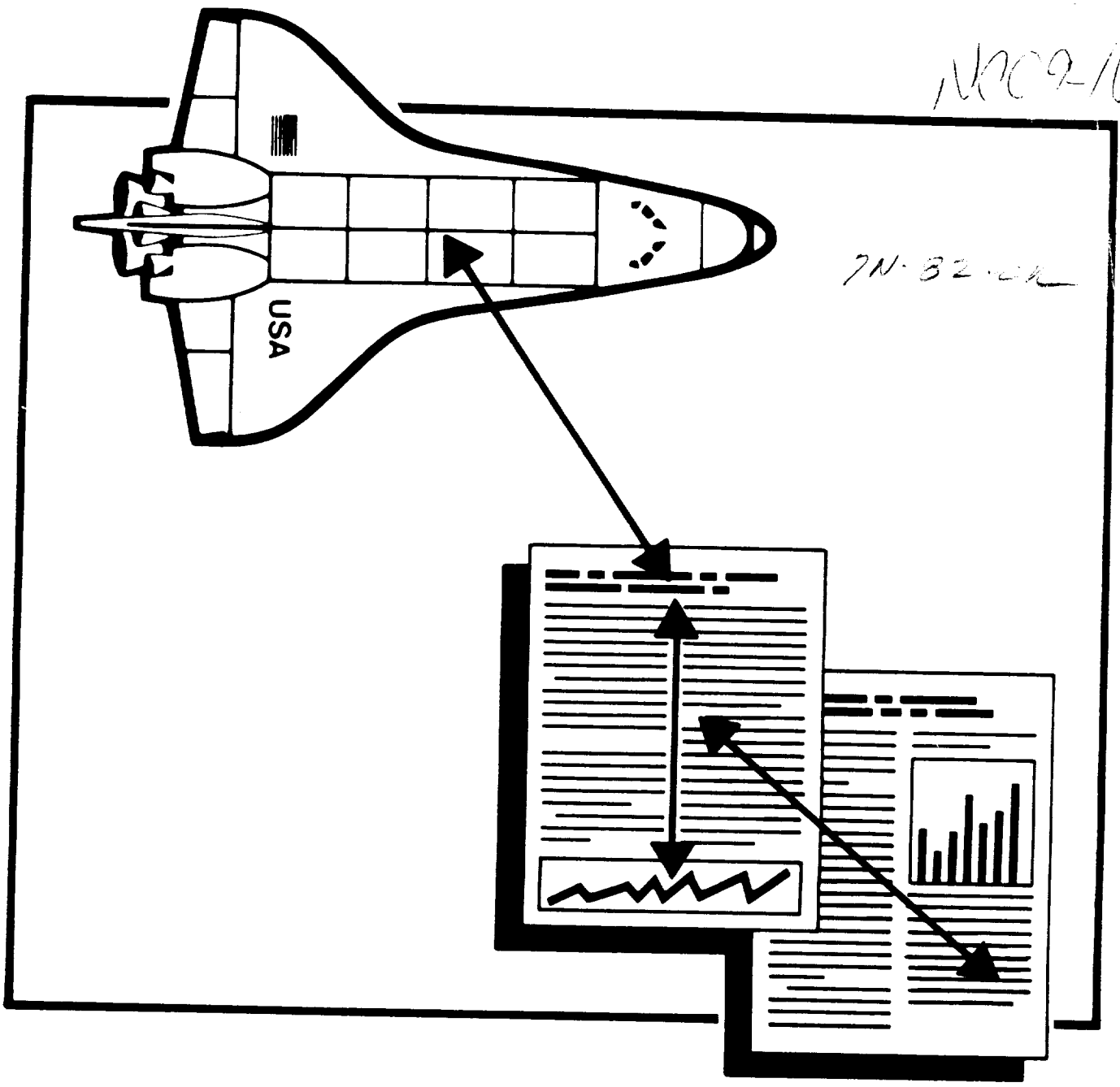

HYPERMEDIA '88 CONFERENCE

HYPERMEDIA '88 CONFERENCE

Sponsored by

University of Houston-Clear Lake
and

NASA/Johnson Space Center

September 14 - 15, 1988

HOUSTON, TEXAS

Hypermedia Steering Committee

Tehchnical Co-Chairs:

Chris Dede, *Professor, School of Education, University of Houston-Clear Lake*

Frank Hughes, *Cheif of Flight Training Branch, Space Station Program, NASA/JSC*

Conference Coordinator:

Katherine Moser, *Coordinator,* SEPEC, *University of Houston-Clear Lake*

Members:

David Auty, *Technical Coordinator, SofTech, Inc.., Houston Operations*

Dona Erb, *Lead Scientist, Mitre Corp.*

Glenn Freedman, *Director,* SEPEC, *University of Houston-Clear Lake*

Stephen Gorman, *Head, Systems Engineering Section, Mission Support Directorate, NASA/JSC*

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Robert Savely, *Head, Artificial Intelligence Section, Mission Support Directorate, NASA/JSC*

Robert Shuler, *Head, Systems Integration Section, Mission Support Directorate, NASA/JSC*

Glen Van Zandt, *Human Resources Development Specialist, NASA/JSC*

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Preface to the Conference Presentation Materials

Why sponsor a conference on hypermedia? We believe that this is "an idea whose time has come." For decades, researchers have been working toward a vision of what hypermedia could be. Now, computational and conceptual advances are combining to make this vision practical. Hypermedia's development seems particularly crucial given the emerging transition from computer systems optimized for data processing to a new paradigm centered on knowledge creation, capture, transfer and utilization.

FROM INFORMATION TO KNOWLEDGE

How do data, information, knowledge, and wisdom differ? As a simplified category system, data is input gathered through the senses, and information is integrated data that denotes a significant change in the environment. Information is converted to knowledge by interconnecting it with known concepts and skills as part of achieving a goal. (Note that knowledge has an attribute of purpose, which implies the existence of an intelligent agent [human or computational] in transforming information into knowledge.) Wisdom adds dimensions beyond individual cognition: the strengths and limits of personal knowledge, how it interrelates to the knowledge of others, ethical and affective issues.

To illustrate, for a software programmer:

- the existence of a new primitive in the programming language would be data
- an understanding of what new functions it adds to the language would be information
- comprehension of how to use the primitive in coding would be knowledge
- mastery of when to use the primitive and of its effects on programming style would be wisdom.

Past generations of information systems have used advances in hardware and software to increase the amount of data available, on the assumption that individual and institutional wisdom would thereby increase. In practice, however,

high levels of data overwhelm people; they become unable to decide which information is important, to interconnect new information into existing knowledge, or to recognize overall patterns of wisdom. To be effective, future generations of advanced information systems must use increases in power to deliver environmentally meaningful, interconnected data (knowledge).

HYPERMEDIA AS KNOWLEDGE REPRESENTATION

For storing knowledge rather than information, non-linear representation formats--such as hypermedia--are superior to linear formats. Researching a topic which is referenced in a variety of interrelated linear documents can be frustrating, since locating a part of the data required often provides little help for finding in other documents the remainder of the information needed. In contrast, a hypermedia system allows the user to follow a web of connections in tracing knowledge scattered in multiple sources.

This property of hypermedia also enhances the capability of documentation to serve as a source for training; a user unfamiliar with the knowledge space can be guided along prestructured paths. Currently, new workers often need substantial amounts of help from an expert human mentor. A major productivity gain would be possible if a hypermedia documentation system could assume some of the responsibility for educating apprentices. In addition, the use of a non-linear representation which mimics human associational memory may give all users greater recall of the material in the knowledge base, since the network's conceptual structure mirrors their internal mental models of the information.

Another advantage of hypermedia is that using text as a method of organizing thoughts about programming, authoring, design, or problem solving can be difficult, since a linear format does not facilitate collecting and integrating a variety of approaches to the task. Current outline processors are limited to sequencing ideas hierarchically but, when concepts can be interrelated in a more complex manner, the brainstorming and synthesis aspects of knowledge creation are easier. Hypermedia as a representation enables both the capture of divergent mental models (as nodes) and their convergence into a coherent strategy (by linking these nodes into a semantic network).

Also, team collaboration on a project is empowered by a non-linear medium because annotations and suggested revisions can be readily incorporated into a document. For example, a chunk of code and related documentation could be circulated electronically to multiple reviewers; the comments of each could be iteratively attached, labeled, and linked until the final hyperversion captured the collective wisdom of the group. In contrast, collecting from team members

amendments to a document in text format is very unwieldy.

Finally, hypermedia formats support modularity of information, a vital strategy in large system development projects. The same node of information can be referenced from multiple locations, minimizing duplication and overlap. This allows greater customization of documents (through tailoring the order and availability of segments), reduces the volume of archival material (since information used in many documents is stored in a single place), and facilitates revision (because only one node need be altered).

CONCLUSION

Hypermedia is a representation system well suited for conceptual exploration, retrieval, training, retention, group collaboration, customization, and revision. The spectrum of knowledge functions a particular hypermedia system supports will depend on what balance among these goal-directed activities is most important to users. This conference focuses on hypermedia applications for design and documentation, software engineering, and education and training. We believe that you will find the ideas which follow both interesting and useful.

Chris Dede
UH-CL

Frank Hughes
NASA/JSC

Introduction to Hypermedia '88

INTRODUCTION AND PURPOSES

Welcome to Hypermedia '88.

There are four purposes we plan to accomplish by hosting **Hypermedia '88**. First and foremost, we plan to raise the level of awareness in the Houston technical community about what hypermedia technology is, and also what the technology can and cannot offer. Notice we said "Houston." When we first planned this conference, our emphasis was to sponsor a regional (rather than national or international) meeting. The national response has been heartening, and we welcome those of you who have traveled to **Hypermedia '88**. Nonetheless, our primary focus remains on the space program and the implications of hypermedia for space applications.

Secondly, we plan to learn from the experience of the speakers and participants to assist us in developing and refining our hypermedia research agenda. The conference speakers are all nationally recognized for their hypermedia expertise, and their presentations are a superb cross-section of the field. The conference's success will measured by the research and applications spurred by the ideas presented.

Thirdly, we plan to encourage a network of hypermedia researchers. The national space program could clearly benefit from hypermedia technologies -- from software engineering to configuration management and version control to training to simulations to knowledge based management systems to document design to collaborative work to ... . Well, you get our drift.

Fourth, we plan to expand the collective knowledge base about hypermedia through the dissemination of the presentations and the follow-up articles that result as well through the word-of-mouth messages you pass to your colleagues.

Our goals are lofty, much like the promise of hypermedia. Here's hoping!

HISTORY AND DIRECTIONS

Like so many other place around the country, in the Houston area hypermedia research has also proliferated, but with little, substantive communication among the research groups. Government, industry and university researchers have been tinkering with hypermedia products and ideas. As an academic institution, UHCL established a "Hypermedia Technology Working Group" in February, 1988 in an effort to bring representatives from different areas together to discuss jointly sponsored projects and to learn from one another. This group has also served as the steering committee for the conference.

From our monthly meetings we decided that raising the awareness of the Houston aerospace community about "hypermedia" would be a priority; hence, this conference. Ron Berry, Director, Mission Support Directorate at Johnson Space Center, encouraged us to continue the meetings and to define a research agenda. Any advice or help you want to provide is greatly appreciated. How can you get involved? Just write or call us. We will try to link you to our node, so to speak... and correspondingly we would like to be linked to yours.

A recurring question has been: "Are you going to have another conference next year?" Our answeris, yes, but only if the interest is there and if it serves the research purposes of the space program. We are not interested in being just another hypermedia conference, but we are interested in promoting research in the field and disseminating that research information to the public. Give us your feedback.

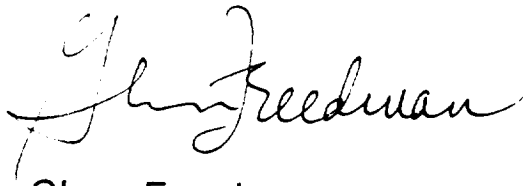
ACKNOWLEDGEMENTS

Conferences succeed as a direct result of the efforts of many people. **Hypermedia '88** would not be the superb program it is without the tireless efforts of the two technical co-chairs, Chris Dede and Frank Hughes. These are two of the class men you will ever meet. In addition, all of the other members of the steering commitee have given freely of their time to ensure the success of the conference. To them all we owe grateful thanks.

Hypermedia '88 is a part of the RICIS Conference Series. RICIS stands for the Research Institute for Computing and Information Systems, a unique cooperative research agreement between UHCL and JSC. Glen Houston, RICIS Director, E.T. Dickerson, Principal Investigator for the research, and Bob MacDonald, Assistant to the Director of the Mission Support Directorate for

Research and Education, have all generously provided their time and support for the conference. In addition, the JSC Human Resource Development Branch, headed by Harvey Hartman, has also provided resources, expertise, and support of every other possible type. Glen Van Zandt, in particular, deserves our hearty thanks.

The conference is produced and managed by the Software Engineering Professional Education Center (SEPEC), a jointly sponsored program of the School of Education and the School of Natural and Applied Sciences at UHCL. SEPEC sponsors many educational and training activities related to software, software engineering and computing systems. We want to thank our staff members who have done so much of the preparation. Eric Lloyd, Linda Curry and Resa McCullin: you are the greatest.



Glenn Freedman

Director

SEPEC

Katherine Moser

Program Coordinator

SEPEC

HYPERMEDIA '88 CONFERENCE

WEDNESDAY SEPTEMBER 14, 1988

1:00 p. m. - 2:15 p. m. — HOUSTON ROOM

HYPERTEXT FOR THE DESIGN PROCESS

Jeff Conklin

Convener: **Frank Hughes - Chief, Flight Operations and Training Branch, Space Station, NASA/Johnson Space Center**

Hypertext promises to support the system development process the way it really is: opportunistic and evolutionary Dr. Conklin will explore two myths about design - the Myth of Product and the Myth of Process.

Dr. Jeff Conklin earned a Ph.D. in Computer Science at the University of Massachusetts at Amherst in the area of natural language processing (a sub-field of AI). Since joining MCC four years ago, he has studied design from a cognitive perspective, exploring theories and tools for the support of large complex system design.

2:15 p. m. - 2:30 p. m. — **REFRESHMENT BREAK** — ATRIUM

2:30 p. m. - 3:30 p. m. — HOUSTON ROOM

AUTOMATIC CONVERSION OF LINEAR PAPER-BASED DOCUMENTS INTO HYPERTEXT

John Leggett

Convener: **Katherine Moser, Coordinator Software Engineering Professional Education Center University of Houston-Clear Lake**

Dr. Leggett will address the process and associated problems of automating the conversion of Linear, Paper-Based Documentation into Hypertext. Issues of granularity of node size, redundancy among a set of documents, and appropriate views over the Hypertext will be discussed. A case study will be presented.

Dr. John Leggett is Assistant Professor of Computer Science at Texas A&M University. His main interests are: Hypertext/Hypermedia Systems, Computer-Interaction, and Systems Programming. In the Fall of 1987 he taught the first course in the country in Hypertext Systems. He formed the Hypertext Research Group at Texas A&M University during the same semester. The HRG currently has funding from IBM; Dr. Leggett directs this lab as well as Master's and Ph.D. research in the Hypermedia area.

3:30 p. m. - 3:45 p. m. — **REFRESHMENT BREAK** — ATRIUM

3:45 p. m. - 4:45 p. m. — HOUSTON ROOM

PROTOTYPE JOB PERFORMANCE ASSISTANCE FOR ON-BOARD SPACE STATION

Dona Erb

Convener: **Robert Shuler, Head, Systems Integration Section Mission Support Directorate NASA/Johnson Space Center**

Job Performance Assistant (JPA) takes the form of crew-initiated searches for information on procedures, maintenance, system configuration, and system functions. Apple Computer Incorporated's Hypercard was used to develop a prototype demonstrating the capability of Hypermedia for JPA with respect to the mobile servicing system for the Space Station.

Dona Erb is Lead Scientist at the Mitre Corporation, currently supporting the Space Station Mission Office of the Missions Operations Directorate, NASA/Johnson Space Center.

5:30 p. m. - 6:30 p. m.	**RECEPTION (Cash Bar)**	**ATRIUM**
6:30 p. m. - 8:30 p. m.	DINNER AND SPEAKER	GALVESTON ROOM

THE FOUR GREAT PROBLEMS OF HYPERMEDIA— AND THEIR SOLUTIONS

Chris Dede

Convener: **Glenn Freedman, Director**
Software Engineering Professional
Education Center
University of Houston-Clear Lake

User disorientation, cognitive overhead, collective communications dysfunctions, and combinatorial explosion all limit hypermedia as a knowledge representation. Robust, inexpensive, and computationally tractible solutions to these problems will be revealed—along with the secrets of transmuting lead to gold and the proof for Fermots' Last Theorem.

Chris Dede is a Full Professor at the University of Houston-Clear Lake, where he directs the Advanced Knowledge Transfer Project. He has been a Visiting Scientist at MIT and at NASA/JSC researching applications of artificial intelligence to education. Chris also works with a variety of industry, government, and professional groups helping them prepare for coming advances in information technology.

THURSDAY, SEPTEMBER 15, 1988

7:45 a. m. - 8:30 a. m.	**CONTINENTAL BREAKFAST**	**ATRIUM**
8:30 a. m. - 9:45 a. m.		HOUSTON ROOM

INTERMEDIA: FUNDAMENTALS OF A MODEL HYPERMEDIA ENVIRONMENT

Paul Kahn

Convener: **Charles Hardwick, Professor**
University of Houston-Clear Lake

The fundamental design of the Intermedia system, a hypermedia application framework being developed at Brown University's Institute for Research in Information and Scholarship, will be demonstrated and discussed. Intermedia consists of a group of integrated application for creating, editing, and viewing text, bitmap, and vector graphics, timelines, video, and animations. It supports the creation and browsing of links among any selection in any document in a multi-user, multi-tasking environment.

Paul Kahn is Project Coordinator at Brown University's Institute for Research in Information and Scholarship, where he has been a full-time researcher since 1985. For the past ten years, he has worked with a variety of text processing systems and full-text databases. His previous positions include Senior Systems Analyst at Harvard University's Office for Information Technology and New Product Applications Specialist for Atex, Inc. (a Kodak Co.)

9:45 a. m. - 10:00 a. m.	**REFRESHMENT BREAK**	**ATRIUM**
10:00 a. m. - 11:00 a. m.		HOUSTON ROOM

TOWARD A RHETORIC FOR HYPERTEXT

John Slatin

Convener: **Harvey Hartman, Chief**
Human Resources Development Branch
NASA/Johnson Space Center

A rhetorical theory for hypermedia must develop both a descriptive vocabulary and a set of compositional principles for documents which have multiple points of entry, multiple exit points, and multiple pathways. Most importantly, a rhetorical theory for hypermedia must begin to define principles and methods for the radically new practices of interactive reading and writing.

John Slatin is an Associate Professor of English at the University of Texas at Austin. He has written books and articles on Twentieth Century Poetry, on Blindness, and on Hypertext and Liberal Education. He received his Ph.D. from Johns Hopkins University.

11:00 a. m. - 11:15 a. m.	**BREAK**	**ATRIUM**

11:15 a. m. - 12:15 p. m. HOUSTON ROOM

THE USE OF HYPERTEXT IN SOFTWARE ENGINEERING APPLICATIONS

David Auty

Convener: Robert Savely, Head, Artificial Intelligence Section
Mission Support Directorate
NASA/Johnson Space Center

Mr. Auty will discuss issues such as automating the development of hypertext documents, providing appropriate support for readers, and managing of hypertext data systems.

Mr. Auty is the Technical Coordinator for SofTech, Inc., Houston Operations. SofTech has maintained an involvement in Hypertext over the last two years through various projects. The most extensive of these was the development of a personal computer based Ada information system which merged the Ada LRM, Ada training materials, and case studies with appropriate referencing links.

12:30 p. m. - 1:30 p. m. **LUNCHEON** **GALVESTON ROOM**

1:45 p. m. - 2:45 p. m. HOUSTON ROOM

A VIRTUAL NOTEBOOK FOR COLLABORATION IN BIOMEDICAL WORK GROUPS

Andy Burger

Convener: Stephen Gorman, Head, Systems Engineering Section
Mission Support Directorate
NASA/Johnson Space Center

At Baylor College of Medicine, we have embodied certain ideas about the behavior of biomedical groups into prototype of the Virtual Notebook. This is a technologically extended analog to the ordinary notebook used as the respository of experimental and clinical data in medicine. The principal features of the Virtual Notebook are a scheme for representing complex information structures, a communication manager for facilitating task assignment and coordination, and a facility for automatically importing relevant information from external sources such as libraries.

Mr. Burger is Project Manager for Integrated Academic Information Management Systems (IAIMS) at Baylor College of Medicine. His work at Baylor, and previously at Texas Instruments, includes development of user interfaces, spatial and relational database design, and decision-support systems based on conventional and AI systems architectures.

2:45 p. m. - 3:00 p. m. **REFRESHMENT BREAK** **ATRIUM**

3:00 p. m. - 4:15 p. m. HOUSTON ROOM

MAINTAINING SOFTWARE LIFE CYCLE DOCUMENTS AS HYPERTEXT

Walt Scacchi

Convener: Robert MacDonald, Assistant for Research and Education
Mission Support Directorate
NASA/Johnson Space Center

The System Factory is an experimental laboratory to study the development, use, and maintenance of software systems. It incorporates a hypertext system which provides access to both an information storage structure and a structured documentation process. Work on an intelligent software hypertext system is now underway.

Dr. Walt Scacchi is an Assistant Professor of Computer Science and Communications at the University of Southern California, where he directs the System Factory Project. His research interests include large-scale software engineering, knowledge-based systems, and social and organizational analysis of computing.

4:15 p. m. - 4:30 p. m. **CLOSING REMARKS** **HOUSTON ROOM**

JEFF CONKLIN

Hypertext for the Design Process

Hypertext for the Design Process

Jeff Conklin

MCC Software Technology Program

September 14, 1988

This is not really a talk about hypertext or hypermedia.

This is an exploration of a new approach to the design of large, complex systems ...

Which just happens to use some hypertext technology ...

But the real point is that this new approach is *process oriented* rather than *artifact oriented.*

The Design Journal: a research program to design a tool which supports this process orientation.

What is Hypertext?

"Hypertext", "Hypermedia" coined by Ted Nelson in 1965.

An information *representation and management* system built around a network of multimedia nodes connected together by links.

- Each node contains a chunk of 'content' such as a paragraph, a document, a sketch or drawing, or a voice annotation.

  Key feature: *computer supported links* represent interrelations among these nodes.

  Access is primarily by navigating (i.e., following links) through the network, usually aided by some sort of map of the global structure of the network.

One Vision of Using Hypertext

The owner of the memex, let us say, is interested in the origin and properties of the bow and arrow. Specifically he is studying why the short Turkish bow was apparently superior to the English long bow in the skirmishes of the Crusades. He has dozens of possibly pertinent books and articles in his memex. First he runs through an encyclopedia, finds an interesting but sketchy article, leaves it projected. Next, in a history, he finds another pertinent item, and ties the two together. Thus he goes, building a trail of many items. Occasionally he inserts a comment of his own, either linking it into the main trail or joining it by a side trail to a particular item. When it becomes evident that the elastic properties of available materials had a great deal to do with the bow, he branches off on a side trail which takes him through textbooks on elasticity and tables of physical constants. He inserts a page of longhand analysis of his own. Thus he builds a [permanent] trail of his interest through the maze of materials available to him.

Vannevar Bush
"As We May Think"
Atlantic Monthly, 1945

Another Vision

The owner of the Design Journal, let us say, is working on the requirements for an elevator control system that his company plans to build. Specifically he is considering whether the control system should have a centralized or a distributed architecture. He has hundreds of possibly pertinent books, articles, policies, simulation results, and previous design histories in his Design Journal. First he pulls up a template for the standard tradeoff analysis for this kind of decision. Next, in a volume of Knuth, he finds an algorithm for centralized resource allocation, and he links this into the analysis. Thus he goes, building a structure of many items. Occasionally he inserts a comment, a note about a problem or idea, or a "todo" item. When it becomes evident that one of the key criteria for the decision is the need to avoid single point failure, he sends an email message to his customer contact opening a discussion about overall system reliability. He notifies several other members of the design team about this discussion, and links the conversation record into the rationale node for this decision. He inserts a freehand sketch of an ring–based distributed architecture. Thus he builds a permanent trail of his deliberation and interactions on this critical design issue.

Jeff Conklin
Hypermedia '88
NASA, 1988

The Problem

Loss of design rationale and history

The WHAT is kept, but the WHY (and the HOW) are never recorded ...
and are soon forgotten.

Roughly 80% of a system's lifecycle cost is in maintenance.

Roughly 50% of maintenance is "re–design" —
trying to understand the original design

The larger and more complex the system, the more opaque it is.

Designers tend to commit too soon

If the problem is complex, the "search space" can be trimmed by making design commitments.

Exploration is hard. And risky. And there is no support for it.

The Solution

Develop technologies which aid in the capture, analysis, and reuse of *design rationale!*

Rationale = History = Record of Process

Tools which support process may "automagically" tap into rationale.

Process = Conversation (i.e. work as conversation, design as conversation)

Thus, the need is for a computer-supported medium of communication!

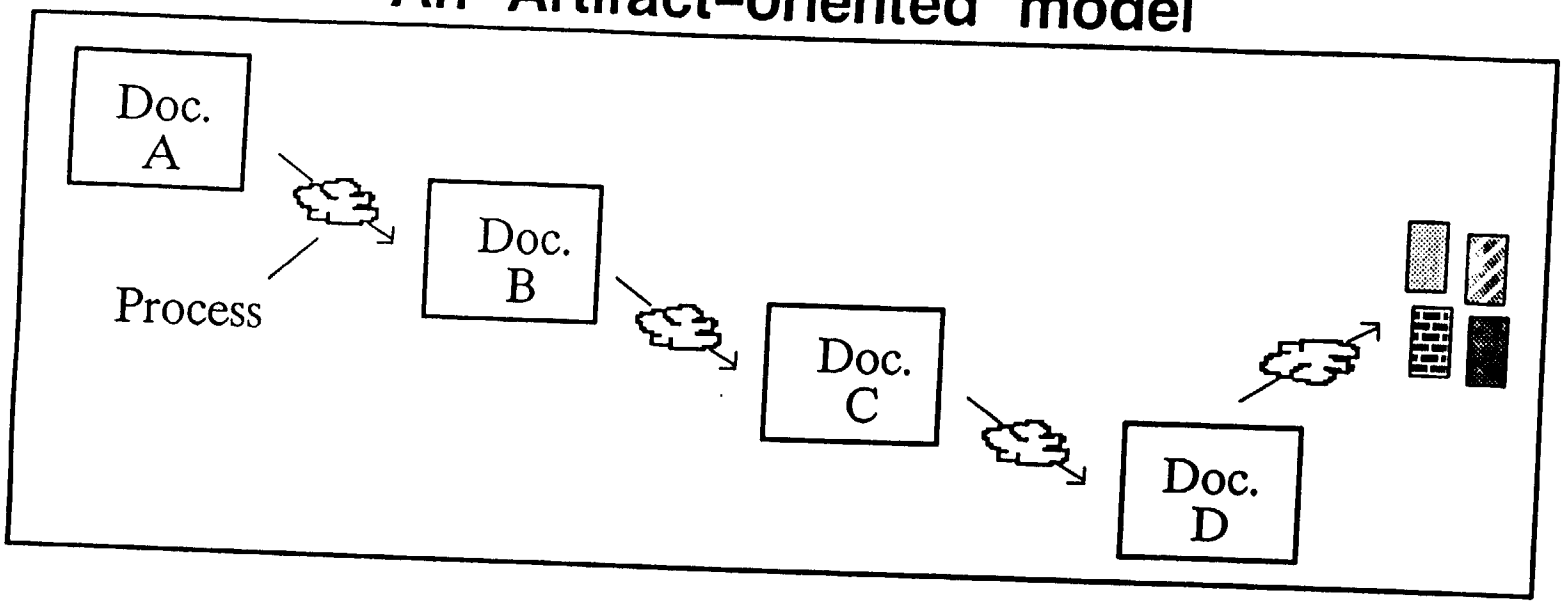
And tracking of issues, assumptions, decisions, problems, etc.

BUT, we live in an *artifact oriented* paradigm and culture.

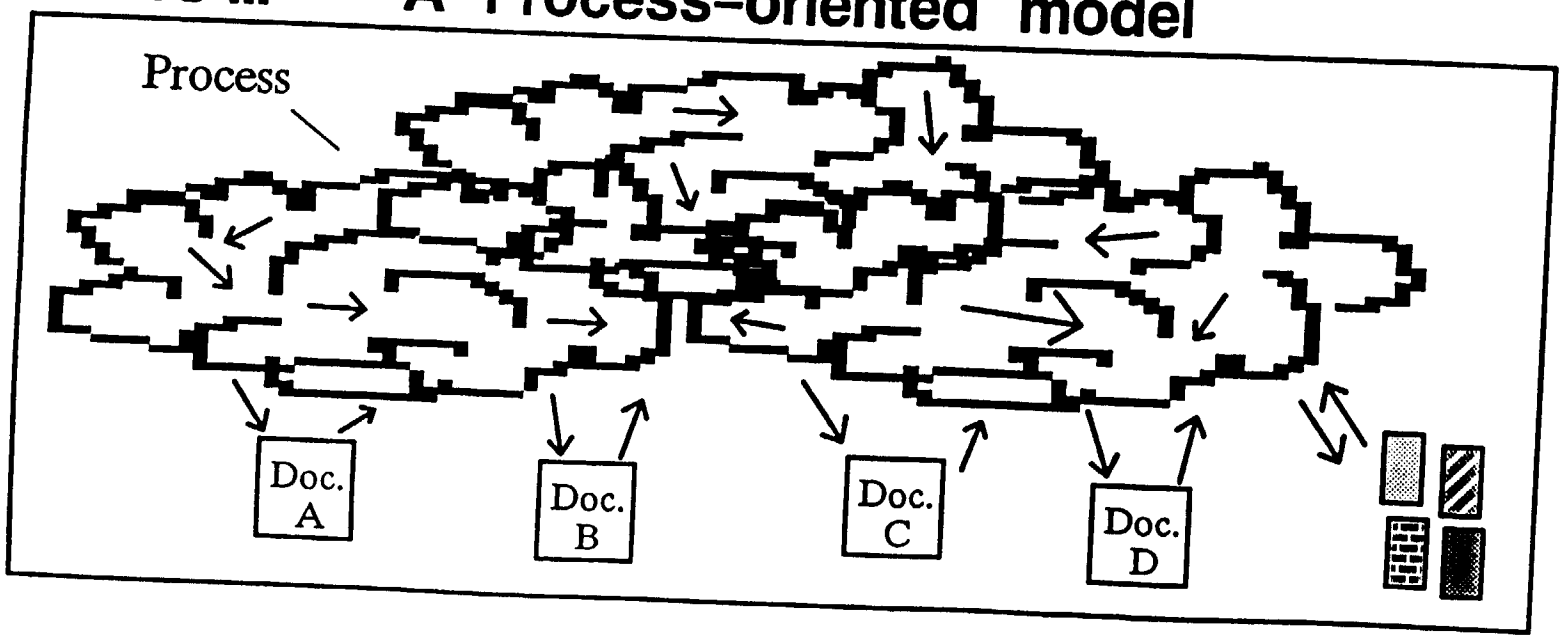
"The ends justify the means."

"Let's stop talking and get to work."

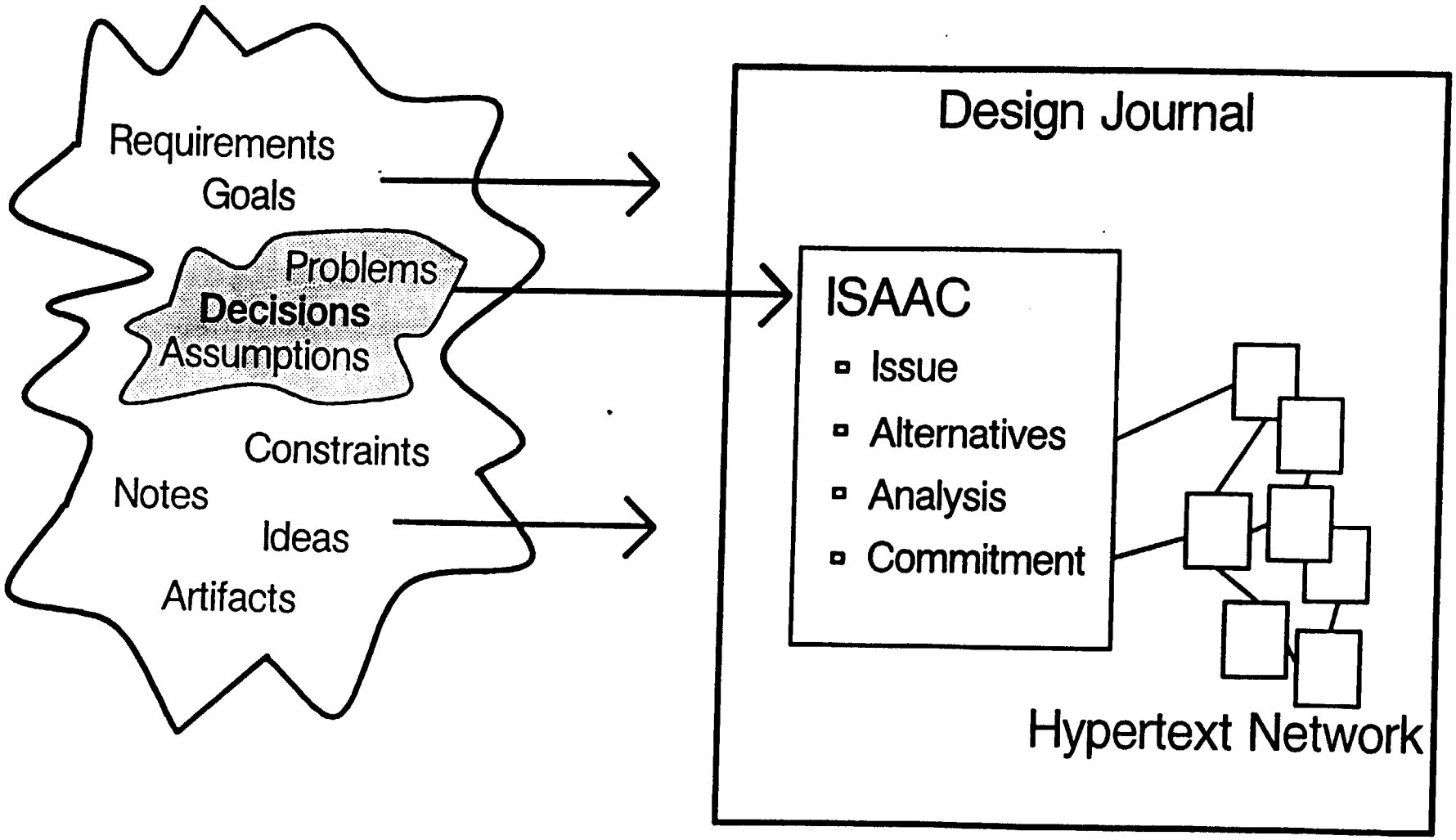
An Artifact-oriented model



VS ... A Process-oriented model



The "stuff" of design ... and ... Its capture; analysis, reuse

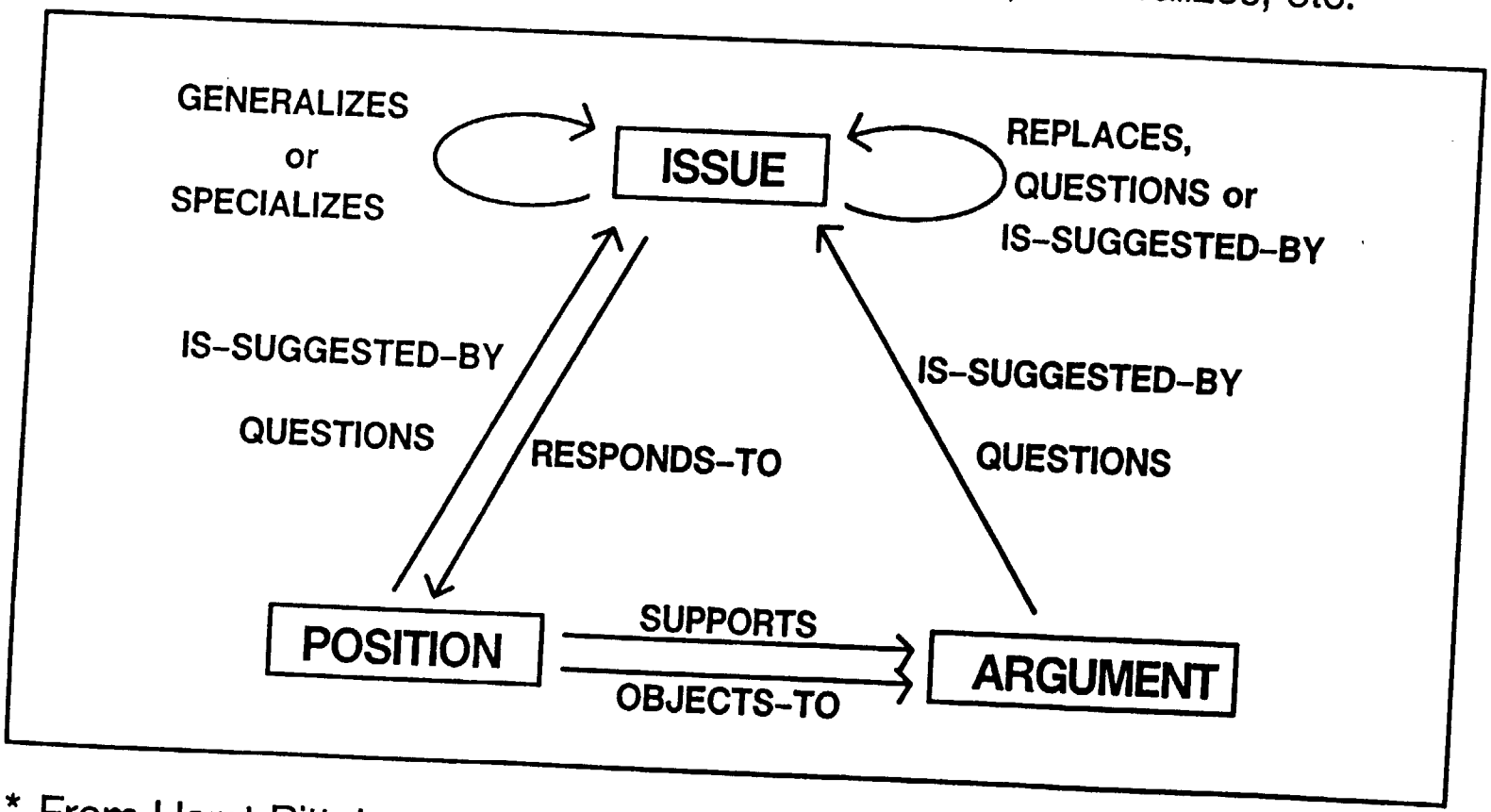


Computer mediated structured dialogue

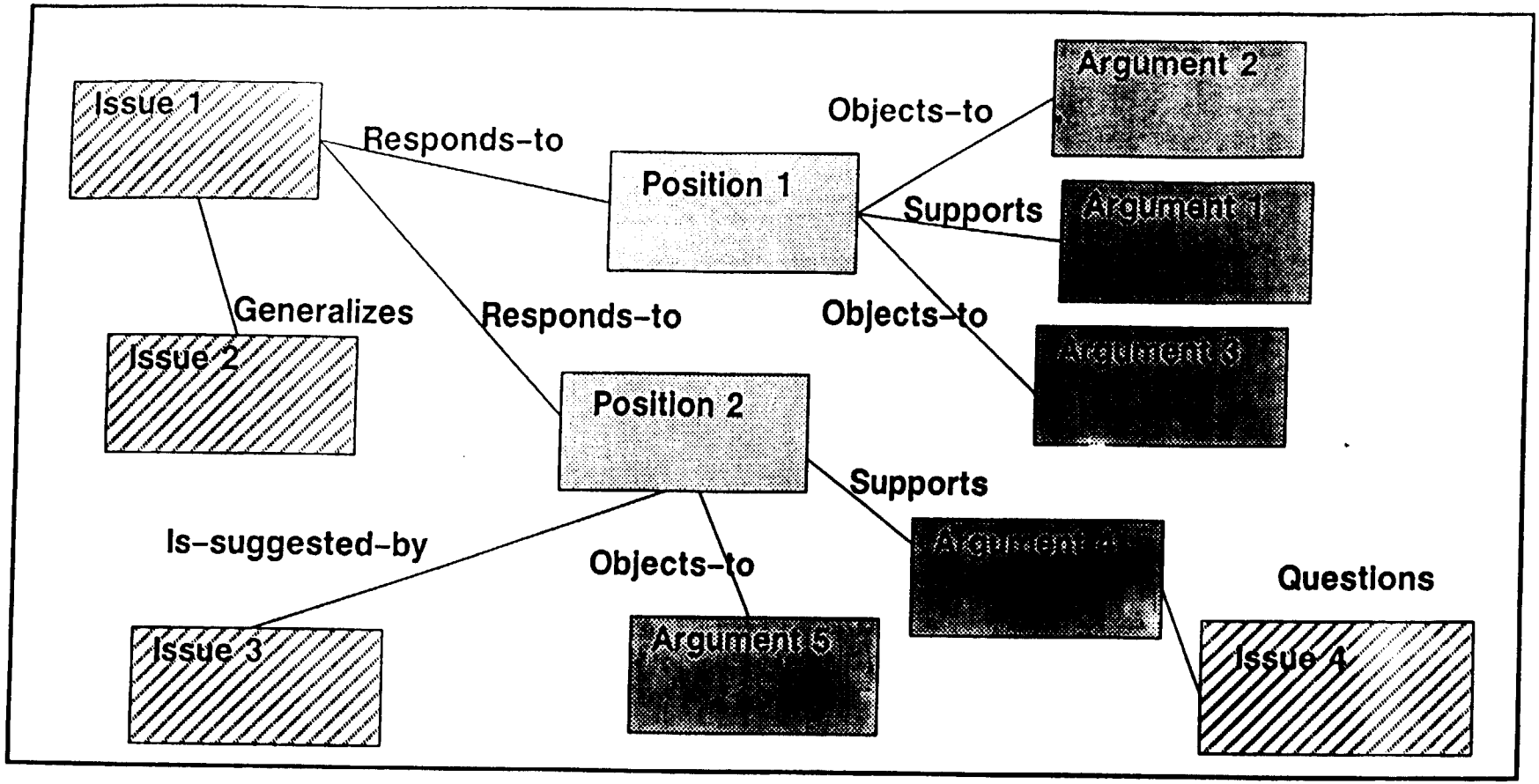
Issue Based Information Systems*: gIBIS -- Planning & Design

Nodes: Issues, Positions, Arguments

Links: Responds–to, Supports, Objects–to, Questions, Generalizes, etc.



* From Horst Rittel



Structured dialogue

Almost real-time interactions

Closed system (now) -- limited integration with artifacts

(video ...)

Some Observations from Using gIBIS

The Usefulness of Explicit Rhetorical Structure

- IBIS is awkward at first
- Individuals: Aid to rigorous thinking, but a lot of work
- Groups: Clear *structure* of the dialogue.

  Exposed "axe grinding, hand waving, and clever rhetoric"

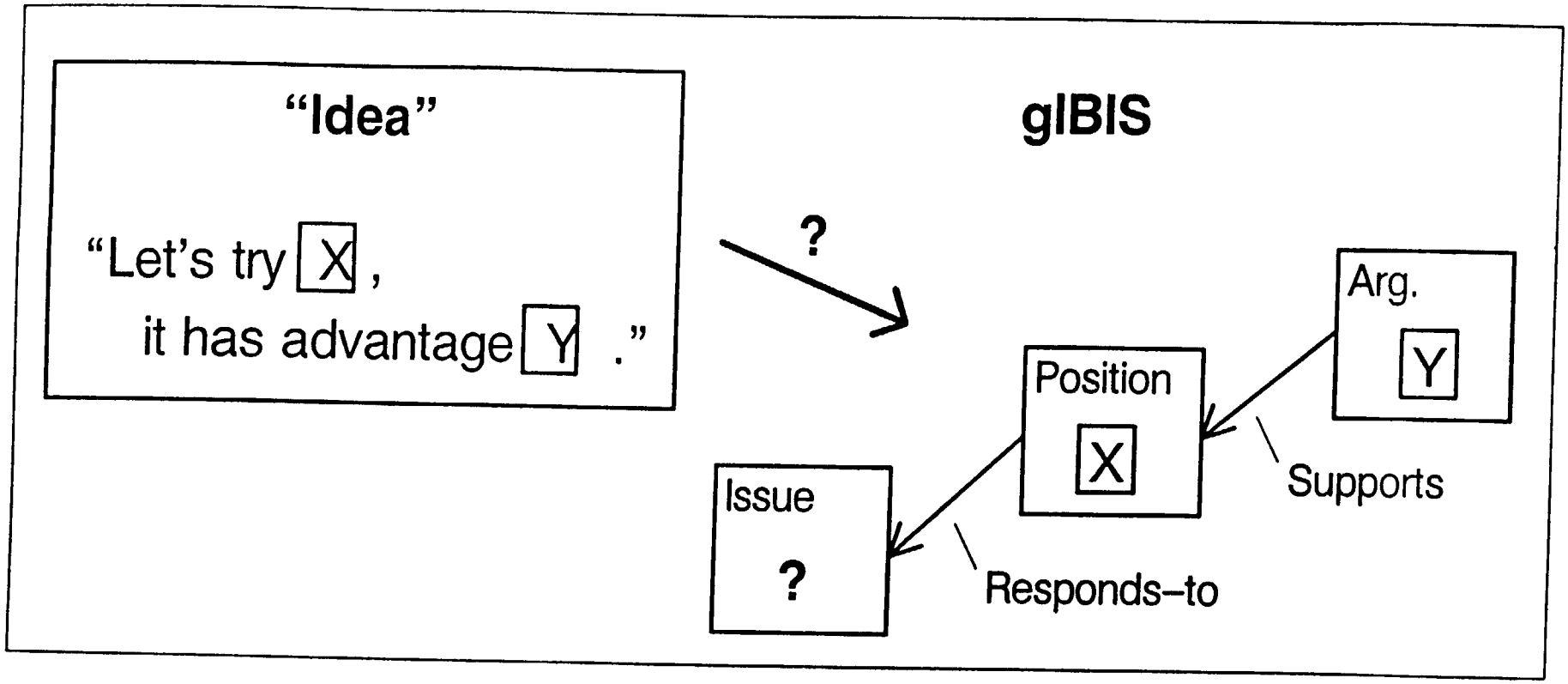
  Made assumptions and definitions explicit
- Referential precision
- Structured conversation complements design decision making

The Synergy of Tool and Method

IBIS		gIBIS
Limited node and link types	⟷	Colored nodes and links
Limited legal "moves"	⟷	Context-sensitive menus
Limited node content	⟷	Fixed-size view window
	⟶	Node-to-node links
Most links short (local)	⟷	Direct manipulation browser

Some General Hypertext Issues ...

The Dangers of Premature Segmentation



Need: "staging" for formalization of vague material

A Problem with Context in Non-linear Documents

- Observed "conceptual fragmentation" in gIBIS nets
  - Discrete chunks obscured the larger idea
- Hypertext encourages "jumping into the middle"
  - What context for arbitrary nodes?
- Possible solutions:
  - Paths, trails, webs
  - Composite nodes (aggregation)
  - Importance measures (a la SYNVIEW)

Coping with Change in an Evolving Network

- Problem solving hypertext systems (e.g. gIBIS)
- Conceptual material "ages" with time

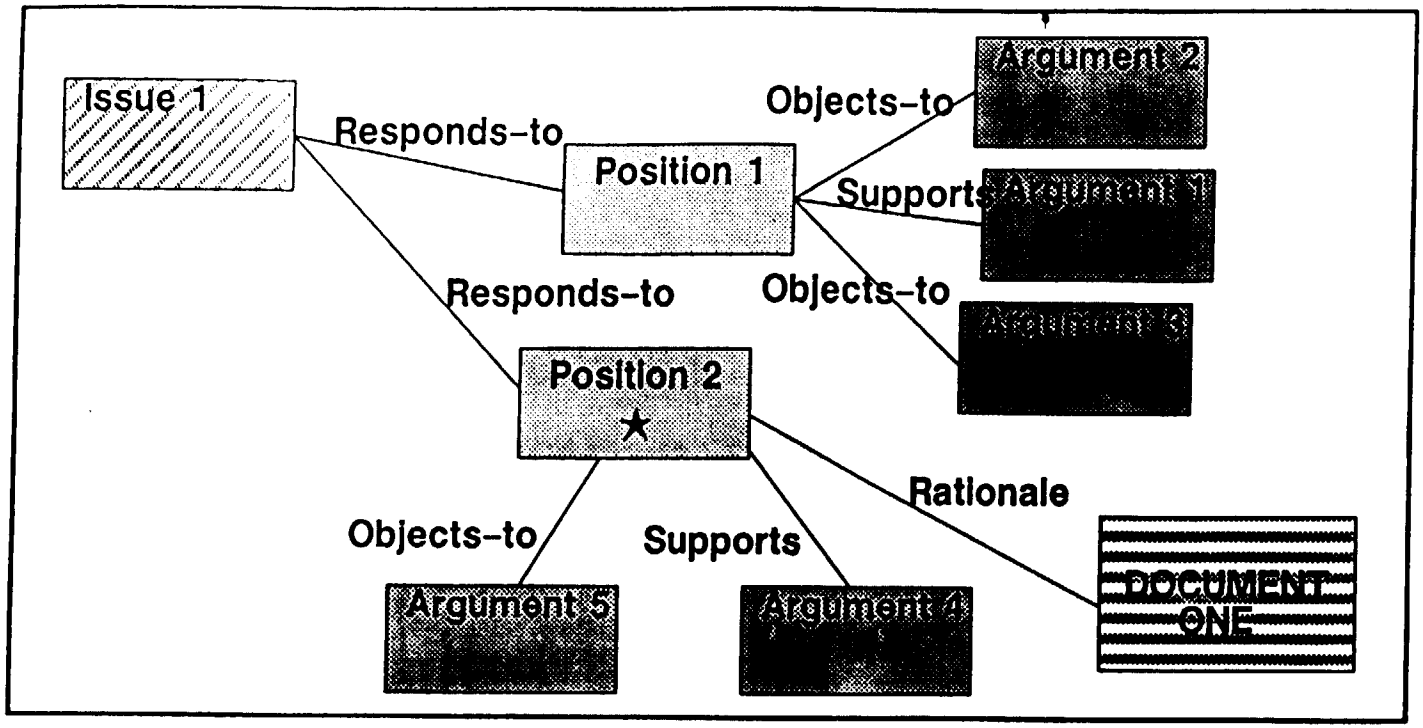
  Ideas become irrelevant, wrong, misleading

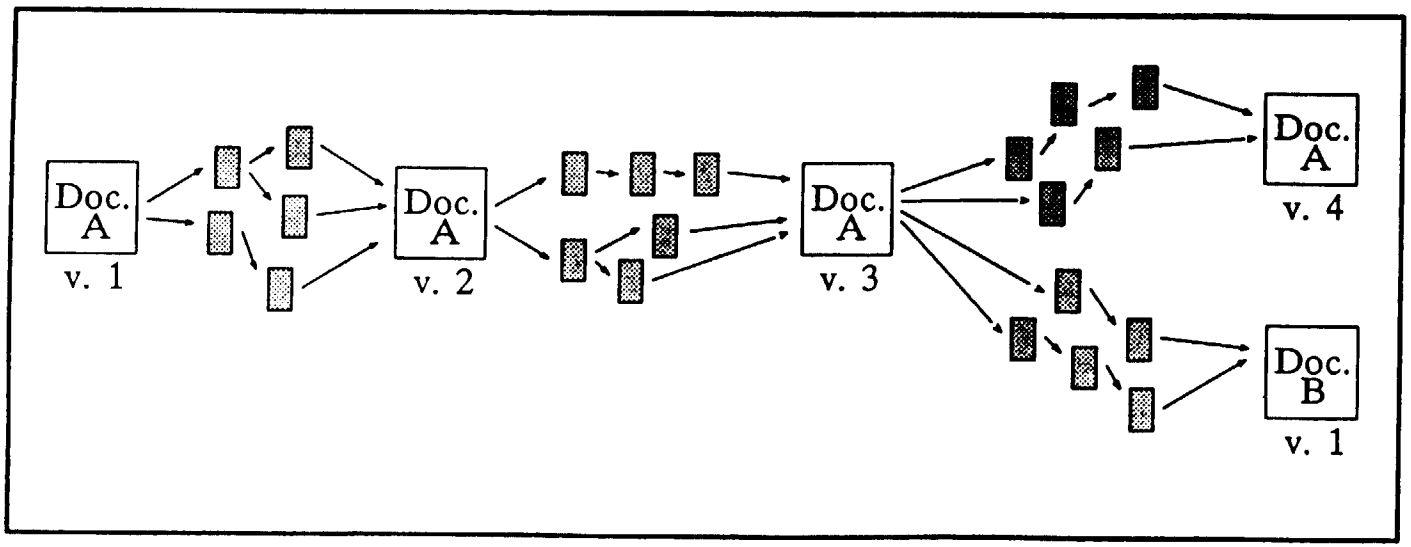
  Example: An Issue's presupposition is later abandoned
- Need to represent and display age and relevance of material

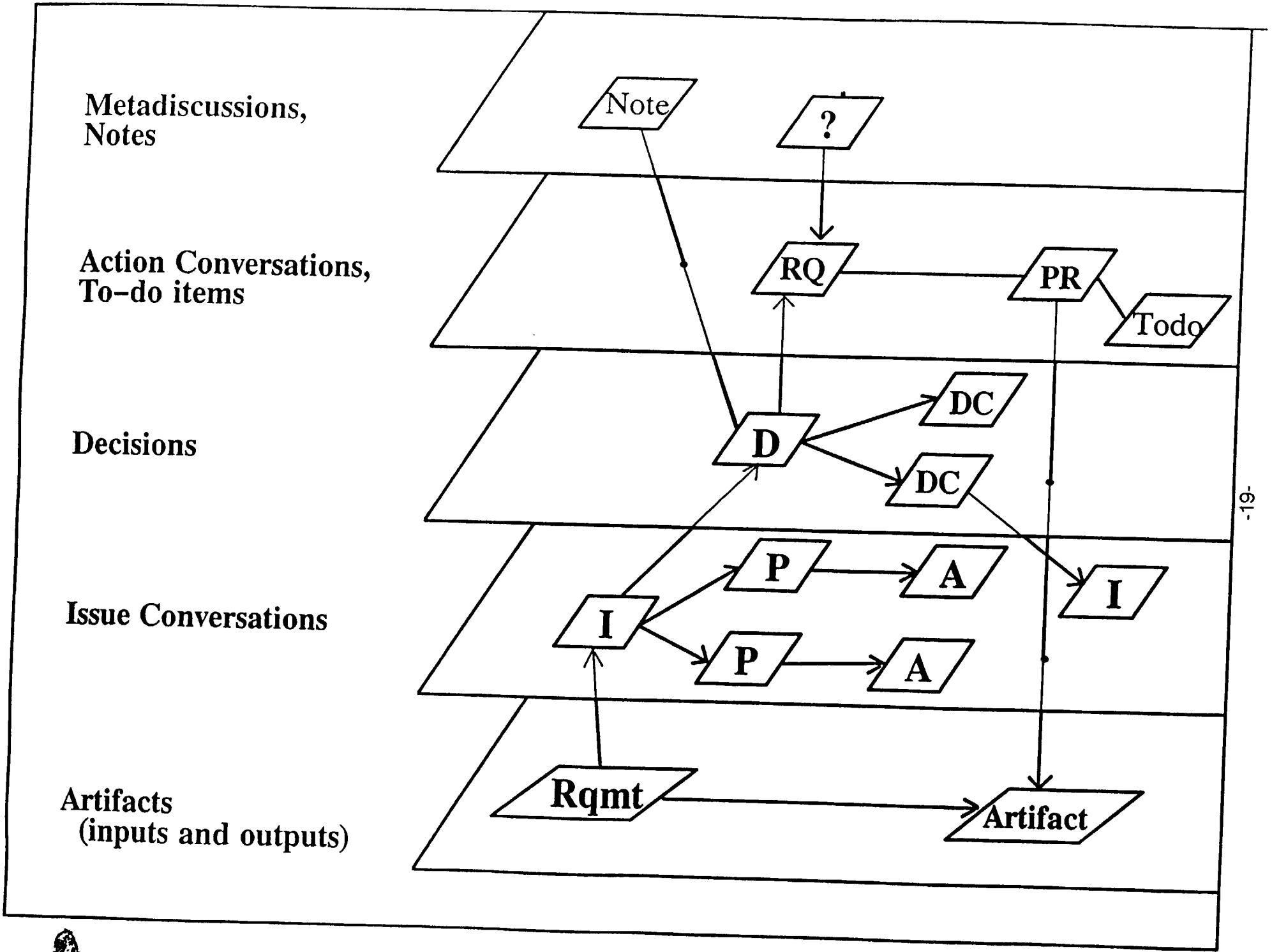
  Yellowing, tattered edges, etc.
- Akin to the truth maintenance problem in AI

  But *semi-structured* -- requires Truth Maintenance Engineer for network hygiene

Integration with Artifacts






Metadiscussions,
Notes
Note
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Action Conversations,
To-do items
RQ
PR
Todo
Decisions
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DC
DC
Issue Conversations
I
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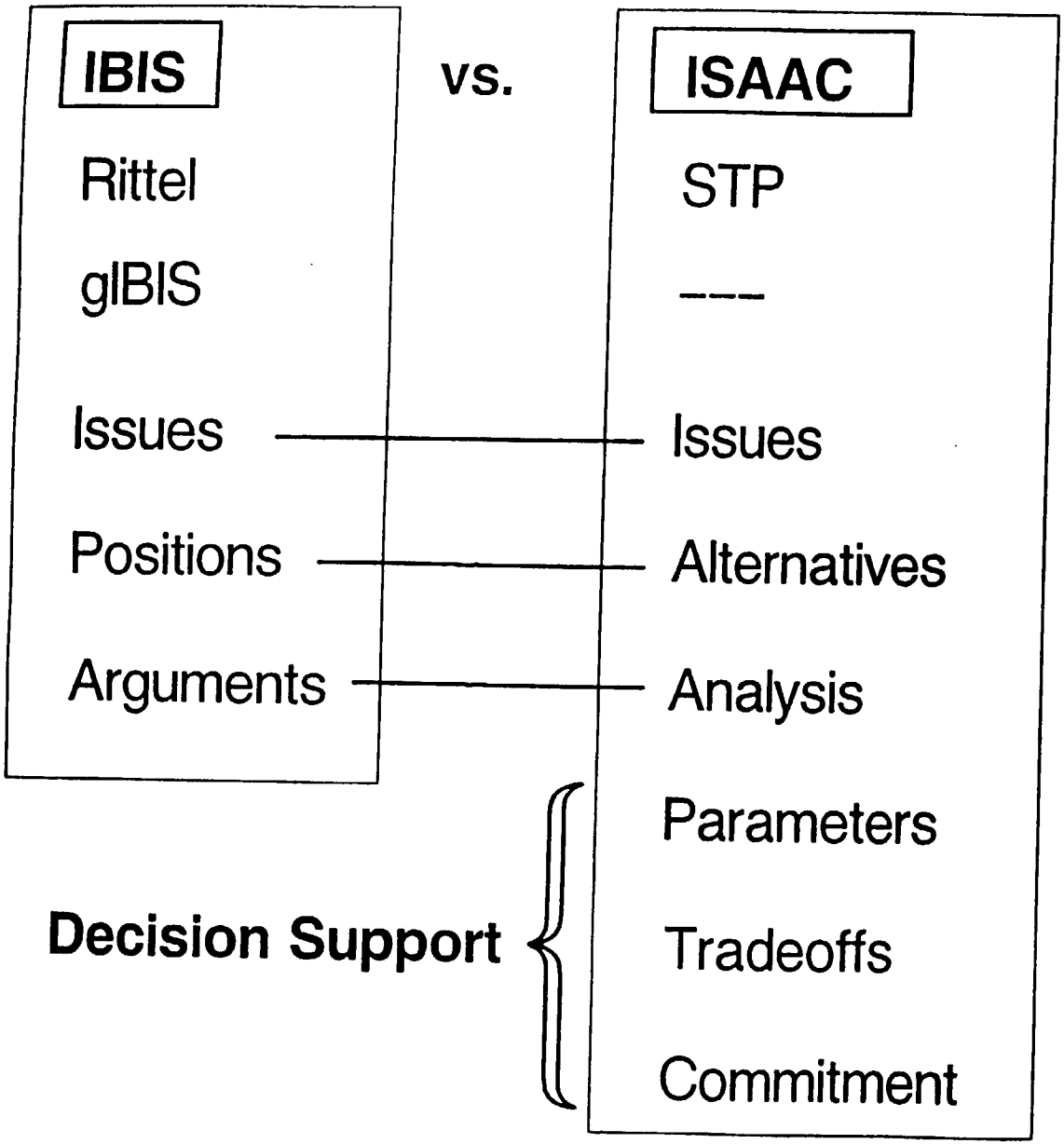
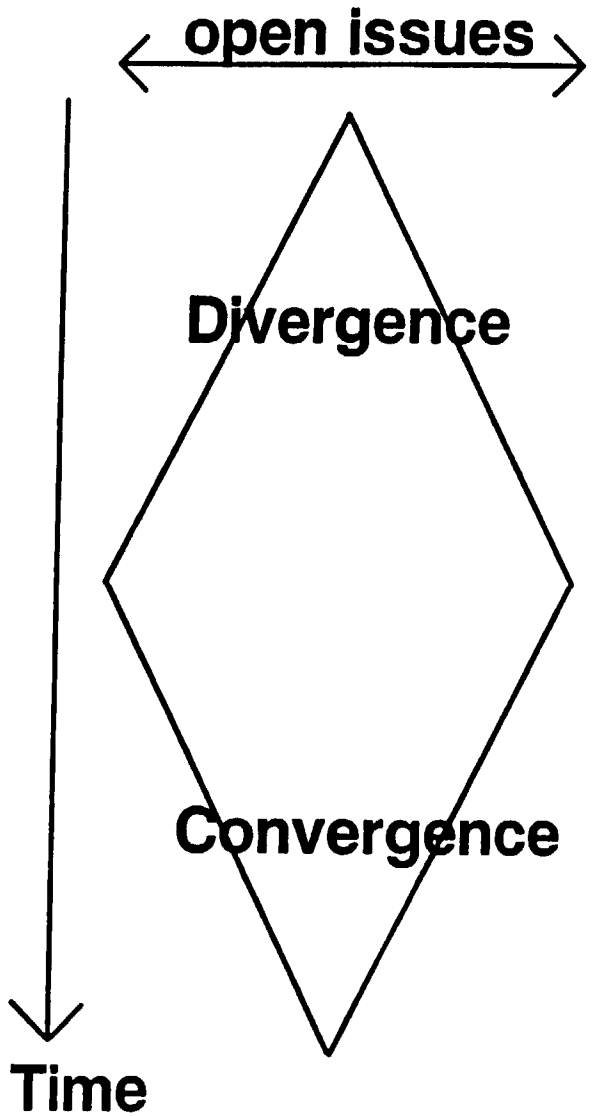
A
P
A
I
Artifacts
(inputs and outputs)
Rqmt
Artifact





ISAACs: The Structure of Design Decisions

Issue

Name: Author: Description: ... Importance:

Alternatives

Alternative #1: Name: Description: ...

Alternative #2 Name: Description: ...

Analysis

Parameters (= Decision Criteria)

Parameter #1: Name: Description: ...

Parameter #2: Name: Description: ...

Matrix:

	P1	P2	P3	...
Atl1	+	–		
Alt2	–	+	R/D*	
⋮				⋱

*** R – Rating, or**

D – Description

Commitment

Pointer to Alt–n (or vector of preferences, or voting record)

Confidence rating:

----------[10:12:51]

S: I'm thinking about the coordination of the N-lifts. Which I haven't thought about before because I thought I was doing it for one, I missed the N-lift system. So I'm **thinking about** the coordination of and a message communication scheme. We **assume** that the physical hardware exists so I can send messages.

E: Yeah, you can assume that.

S: I've got to think about this a minute. How I'm going to do... You know when the fellow on the floor presses the up button, I'm going to schedule the elevators. Do we have a central controller? We don't say do we. We have a central controller or a distributed controller, is that up to me?

E: That's up to the designer. That's up to you.

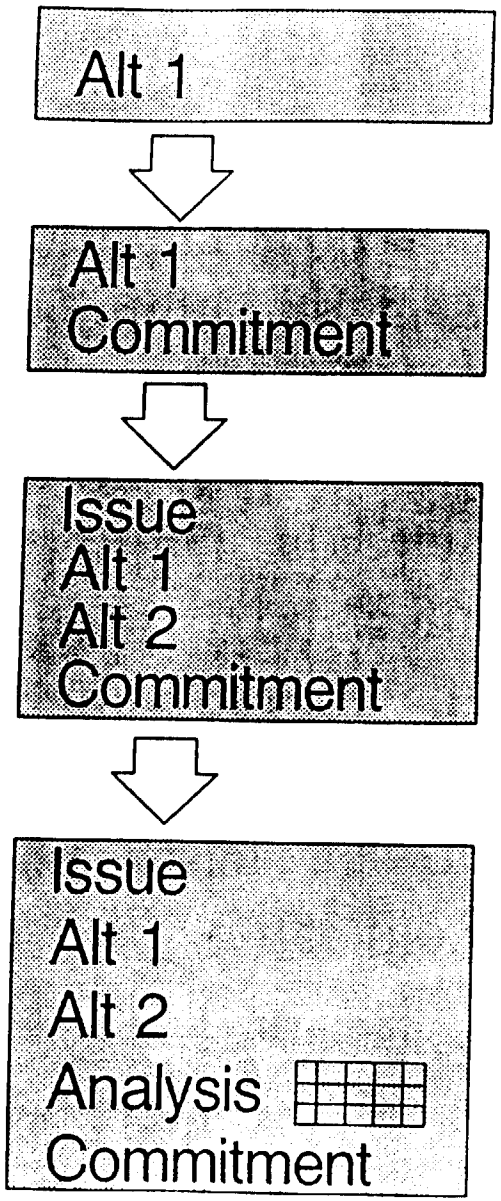
S: I mean if I asked for it, I can have a central control dispatcher?

E: Yeah.

----------[10:14:08]

S: Of 'Course the **good news** about central control is it's an easier algorithm versus distributed control. The **bad news** is you have a single point of failure. Ah, there's no failure criteria. There's no failure criteria stated in the algorithm. You've got to make an **assumption**. You would rather not have a single point of failure because if, you know if all the elevators in the building that are going to go down if it goes down. Like if you had a fire, well they shouldn't use elevators in a fire anyhow. In any event, you wouldn't want everything to go down.

The maturing of an ISAAC (example)



a vague idea

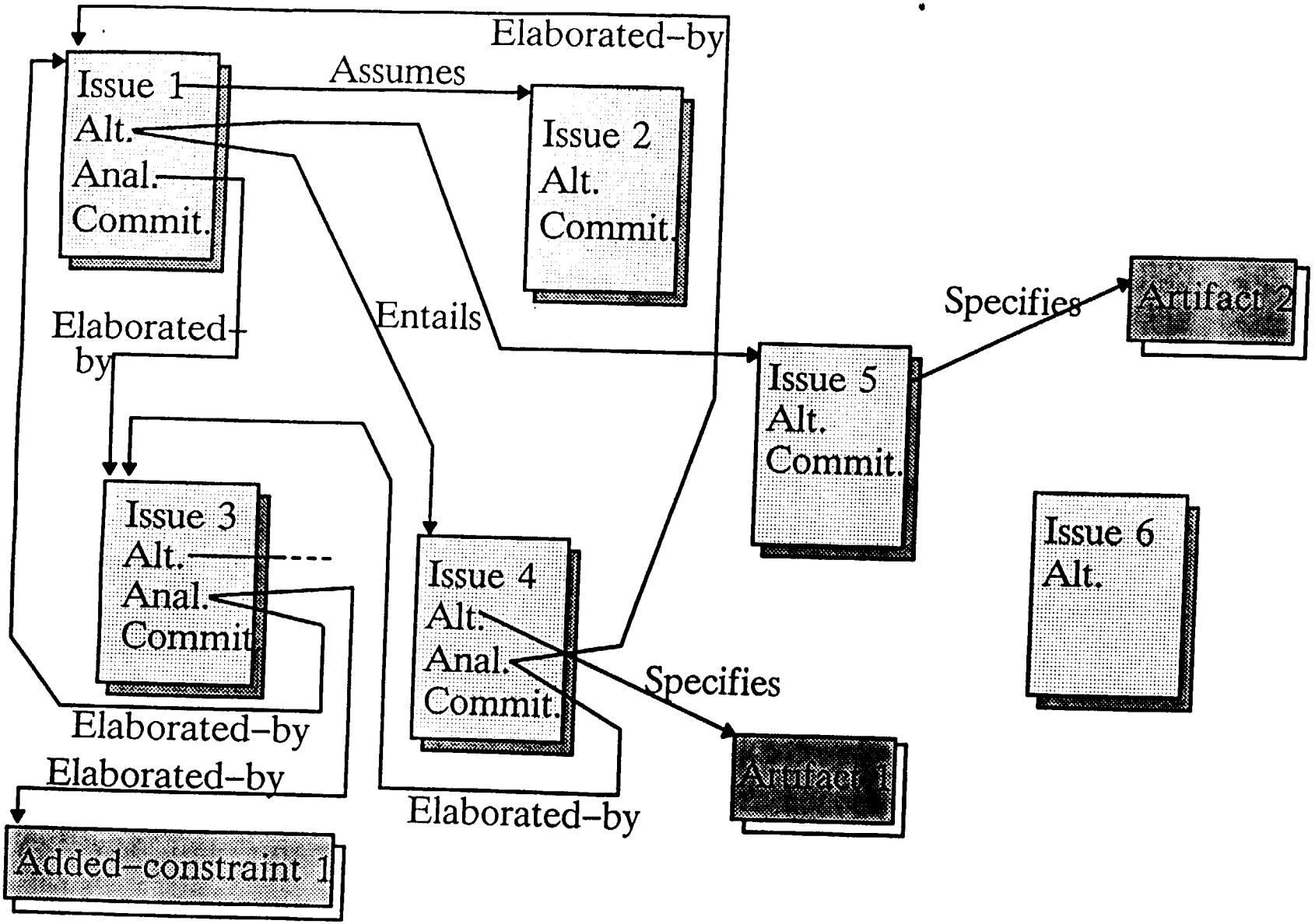
an assumption

a quick decision

a careful decision

Time

A Piece of the Subject 6 ISAAC Analysis Network



ISAAC #1

Issue:

A1: --

Criteria

Analysis

Commitment: *A1*

-26-

A Design Journal Scenario

ISAAC #1

Issue: Elevator coordination: centralized or distributed?

A1: Centralized
A2: Distributed

Criteria

Analysis

Commitment: *Unresolved*

ISAAC #1

Issue: Elevator coordination: centralized or A single processor for the whole system.

A1: Centralized
A2: Distributed

Criteria

Analysis

Commitment: *Unresolved*

ISAAC #1

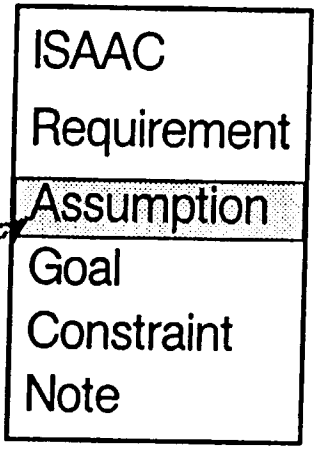
Issue: Elevator coordination: centralized or distributed?

A1: Centralized
A2: Distributed

Criteria

Analysis

Commitment: *Unresolved*



ISAAC #1

Issue: Elevator coordination: centralized or distributed?

A1: Centralized
A2: Distributed

Criteria

Analysis

Commitment: *Unresolved*

• Assumptions

1. The underlying substrate for message communication exists.

ISAAC #1

Issue: Elevator coordinatic
distributed?

A1: Centralized
A2: Distributed

Criteria

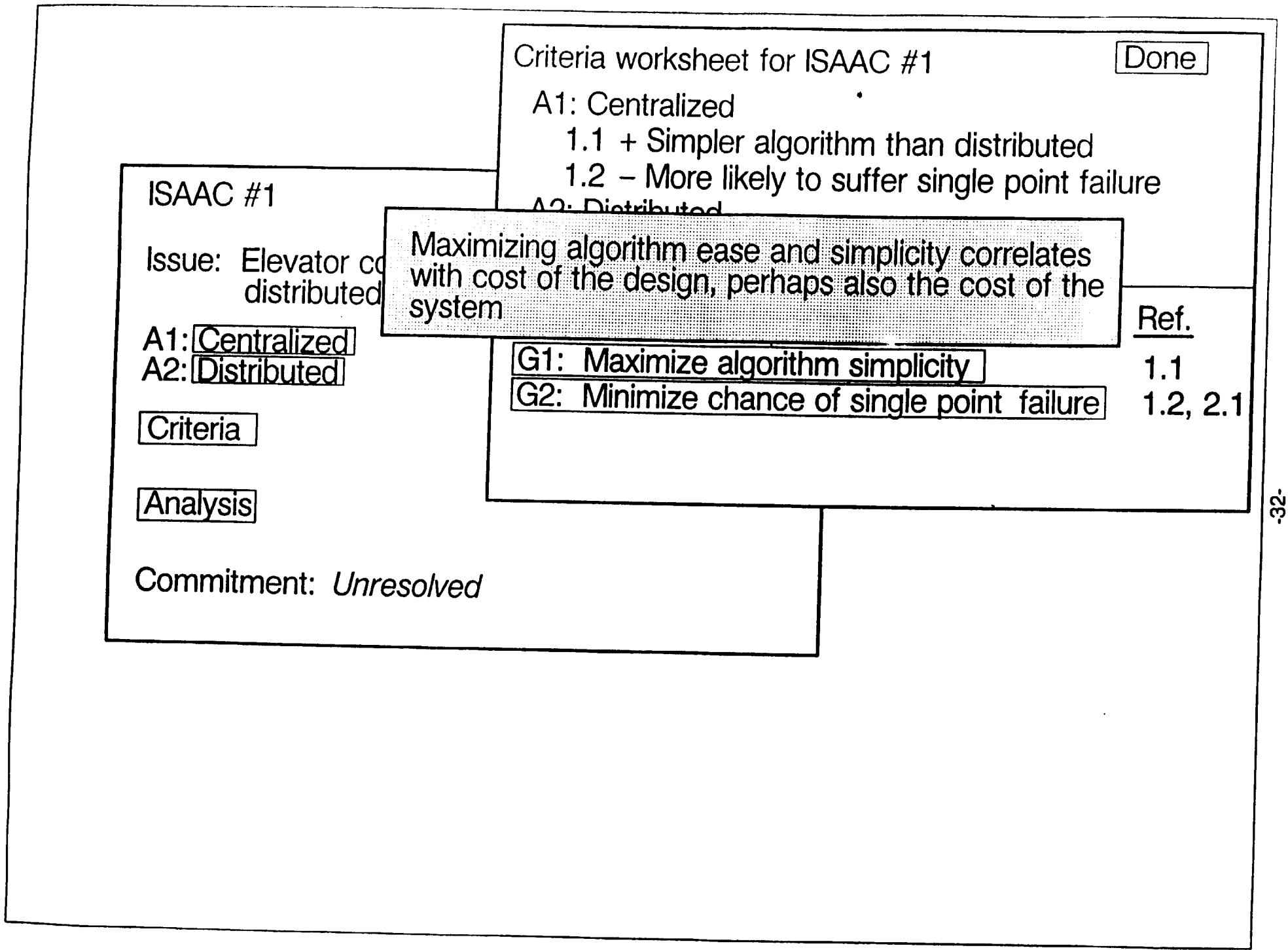
Analysis

Commitment: *Unresolved*

Criteria worksheet for ISAAC #1 Done

A1: Centralized
1.1 + Simpler algorithm than distributed
1.2 – More likely to suffer single point failure
A2: Distributed
2.1 + Avoids single point failure

Goals	Ref.
G1: Maximize algorithm simplicity	1.1
G2: Minimize chance of single point failure	1.2, 2.1


Criteria worksheet for ISAAC #1
Done
A1: Centralized
1.1 + Simpler algorithm than distributed
1.2 – More likely to suffer single point failure
ISAAC #1
Issue: Elevator co
distributed
A1: Centralized
A2: Distributed
Criteria
Analysis
Commitment: Unresolved
Maximizing algorithm ease and simplicity correlates with cost of the design, perhaps also the cost of the system
Ref.
G1: Maximize algorithm simplicity
1.1
G2: Minimize chance of single point failure
1.2, 2.1

-32-

ISAAC #1

Issue: Elevator coordination: centralized or distributed?

A1: Centralized
A2: Distributed

Criteria

G1: Maximize algorithm simplicity
G2: Minimize chance of single point failure

Analysis

Commitment: *Unresolved*

ISAAC #1

Issue: Elevator coordination: centralized or distributed?

A1: Centralized
A2: Distributed

Criteria

G1: Maximize algorith
G2: Minimize chance

Analysis

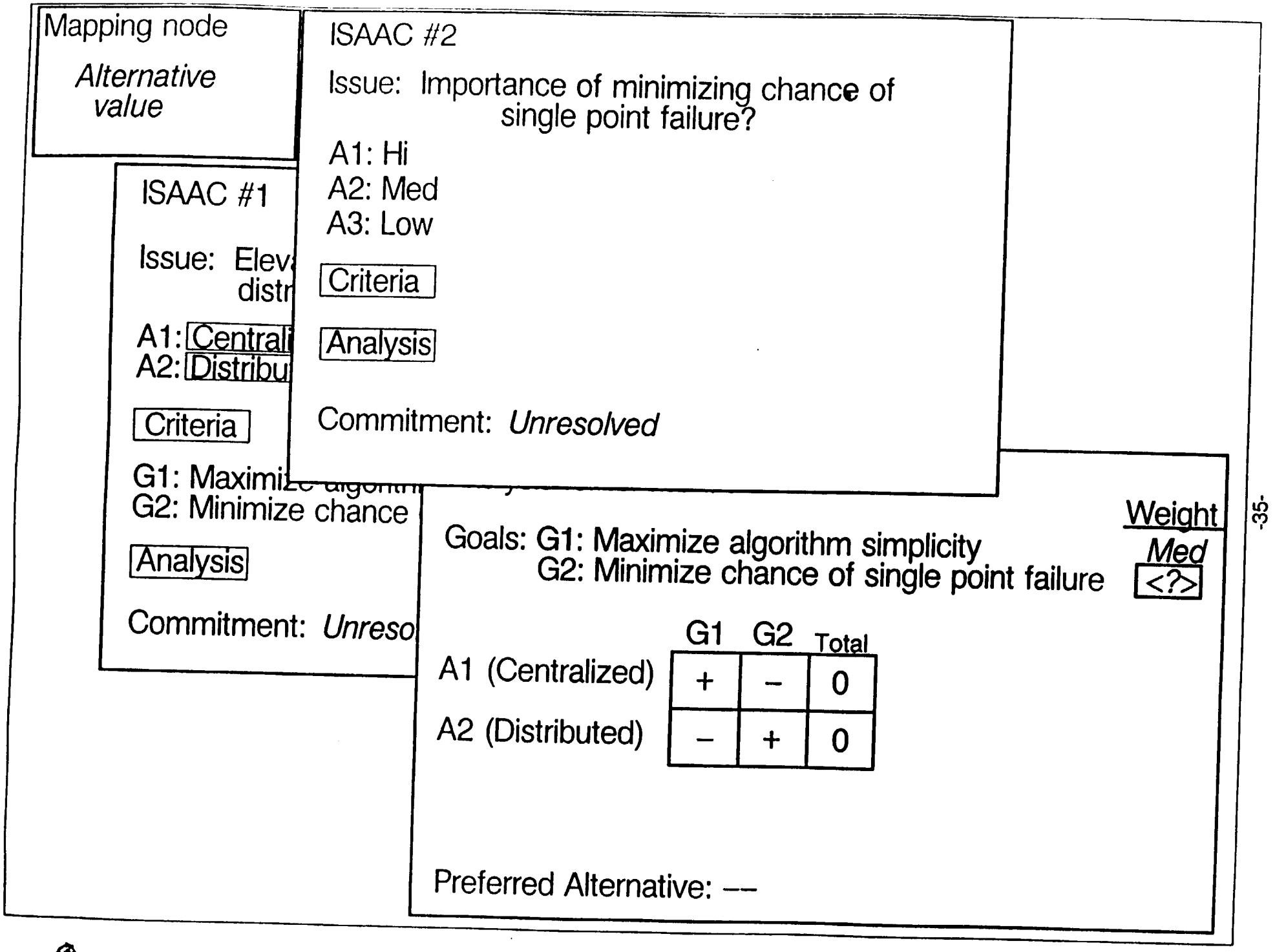
Commitment: *Unreso*

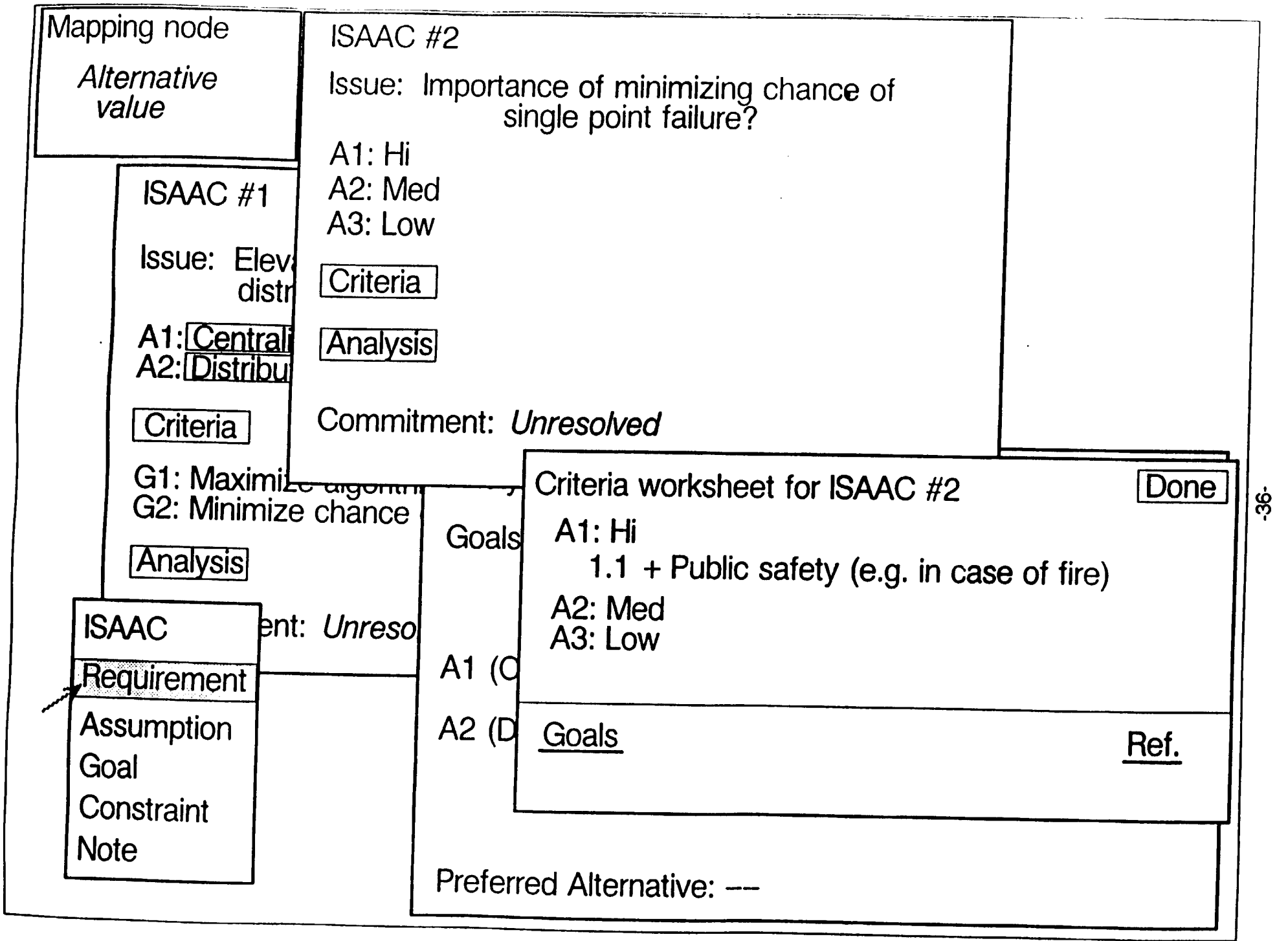
Analysis for ISAAC #1

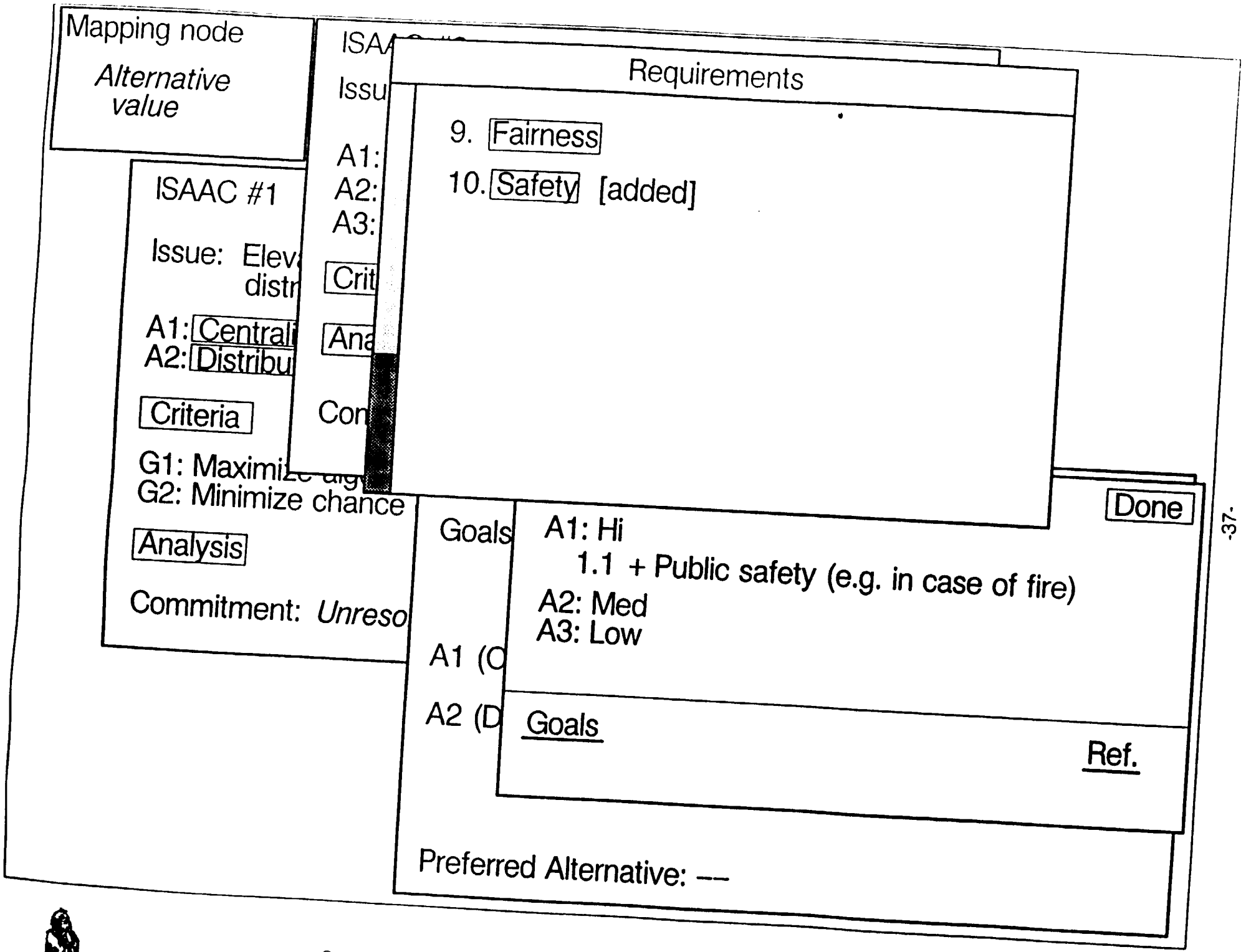
Goals: G1: Maximize algorithm simplicity — Weight: *Med*
G2: Minimize chance of single point failure — Weight: *Med*

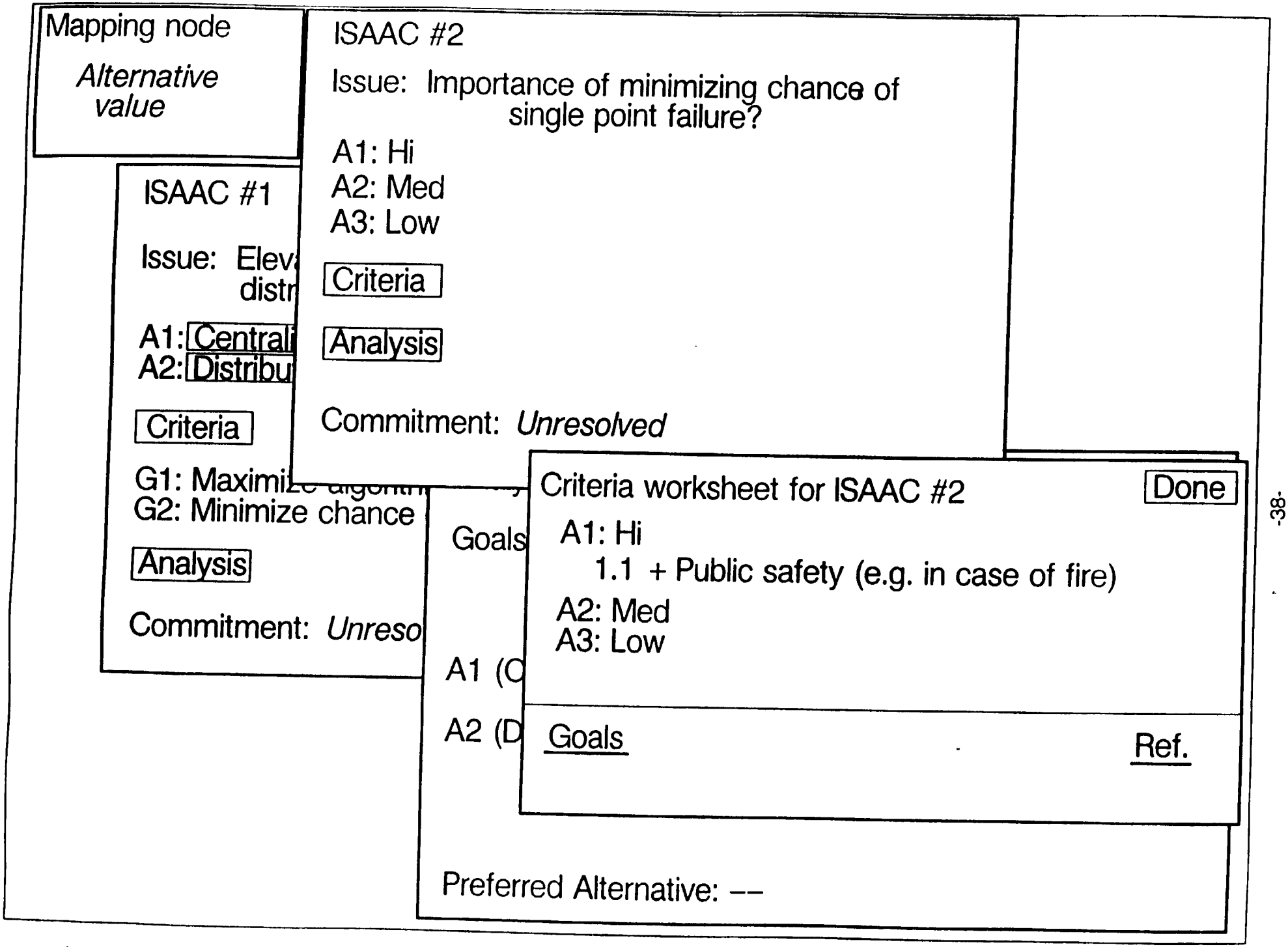
	G1	G2	Total
A1 (Centralized)	+	–	0
A2 (Distributed)	–	+	0

Preferred Alternative: --


Mapping node
Alternative value
ISAAC #2
Issue: Importance of minimizing chance of single point failure?
A1: Hi
A2: Med
A3: Low
Criteria
Analysis
Commitment: Unresolved
ISAAC #1
Issue: Elev
distr
A1: Centrali
A2: Distribu
Criteria
G1: Maximize algorithm
G2: Minimize chance
Analysis
Commitment: Unreso
Weight
Med
<?>
Goals: G1: Maximize algorithm simplicity
G2: Minimize chance of single point failure
G1 G2 Total
A1 (Centralized) + – 0
A2 (Distributed) – + 0
Preferred Alternative: --
-35-


Mapping node
Alternative value
ISAAC #2
Issue: Importance of minimizing chance of single point failure?
A1: Hi
A2: Med
A3: Low
Criteria
Analysis
Commitment: Unresolved
ISAAC #1
Issue: Elev
distr
A1: Centrali
A2: Distribu
Criteria
G1: Maximi
G2: Minimize chance
Analysis
ISAAC
Requirement
Assumption
Goal
Constraint
Note
Goals
A1 (C
A2 (D
Criteria worksheet for ISAAC #2
Done
A1: Hi
1.1 + Public safety (e.g. in case of fire)
A2: Med
A3: Low
Goals
Ref.
Preferred Alternative: ---




Mapping node
Alternative value
ISAAC #2
Issue: Importance of minimizing chance of single point failure?
A1: Hi
A2: Med
A3: Low
Criteria
Analysis
Commitment: Unresolved
ISAAC #1
Issue: Elev
distr
A1: Centrali
A2: Distribu
Criteria
G1: Maximiz
G2: Minimize chance
Analysis
Commitment: Unreso
Goals
A1 (C
A2 (D
Criteria worksheet for ISAAC #2
Done
A1: Hi
1.1 + Public safety (e.g. in case of fire)
A2: Med
A3: Low
Goals
Ref.
Preferred Alternative: --

Mapping node

Alternative value

ISAAC #2

Issue: Importance of minimizing chance of single point failure?

A1: Hi
A2: Med
A3: Low

Criteria

Analysis

Commitment: *A1*

ISAAC #1

Issue: Elev
distr

A1: Centrali
A2: Distribu

Criteria

G1: Maximize algorithm
G2: Minimize chance

Analysis

Commitment: *A2*

Analysis for ISAAC #1

Goals: G1: Maximize algorithm simplicity
G2: Minimize chance of single point failure

Weight
Med
Hi

	G1	G2	Total
A1 (Centralized)	+	–	–
A2 (Distributed)	–	+	+

Preferred Alternative: A2

-39-

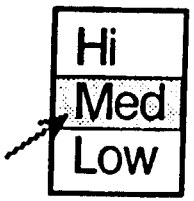
ISAAC #1

Issue: Elevator coordination: centralized or distributed?

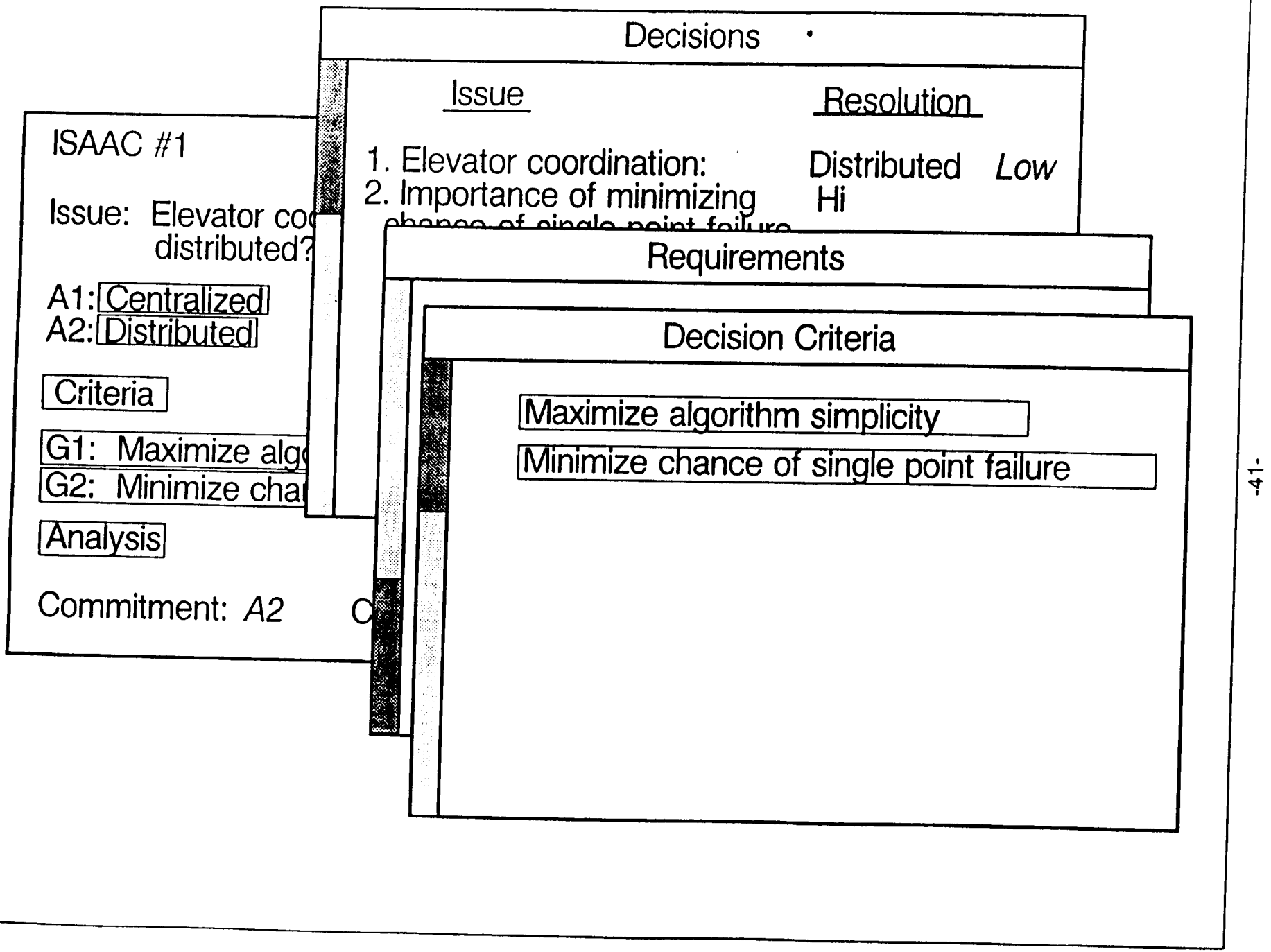
A1: Centralized
A2: Distributed

Criteria

Analysis



Commitment: *A2* Confidence: ---


Decisions
Issue
Resolution
ISAAC #1
1. Elevator coordination:
Distributed
Low
2. Importance of minimizing
Hi
Issue: Elevator co
distributed?
Requirements
A1: Centralized
A2: Distributed
Decision Criteria
Criteria
Maximize algorithm simplicity
G1: Maximize alg
Minimize chance of single point failure
G2: Minimize cha
Analysis
Commitment: A2
C

The benefits of computer-mediated design rationale

For the individual designer ...

- **Rigor**
- **Complexity Management**
- **Exploration**
- **"in vivo" documentation**

For the project and design team ...

- **On-line (computer mediated communication)**
- **Reviews (micro)**
- **Inference**
- **Management**

For the corporation ...

- **Informal knowledge capture**
- **Reuse (repeat business)**
- **Training**
- **Maintenance**

The Challenges of this Approach

Technical problems

Input -- getting all this rationale into the computer

Templates
Voice input
Apprentices (for master designers)
Secretaries (for groups)

Retrieval -- getting it back out

Search/browsing
Composite structures
Filters

Analysis -- beyond mere storage

"Inference" over structured nodes and links
Cheap NLP?
Explicit rhetorical structure

Social & organizational problems

The Myth of Product

"The only thing that really counts is the product."
Where does quality come in?
Ignores tools, training/education, culture

The Myth of Process

"The process can be improved by making it algorithmic."
Ignores the way people really work
Design problems are "wicked"
Design is "opportunistic"

JOHN LEGGETT

Automatic Conversion of Linear Paper-Based Documents into Hypermedia

45 + 46

Automatic Conversion of Linear, Paper-Based Documents into Hypertext

Dr. John Leggett
Hypertext Research Lab
Department of Computer Science
Texas A&M University

Outline of Talk

- Discussion of the Rexx Project
- Considerations for Converting Text into Hypertext
- What are we doing, anyway?

Discussion of the Rexx Project

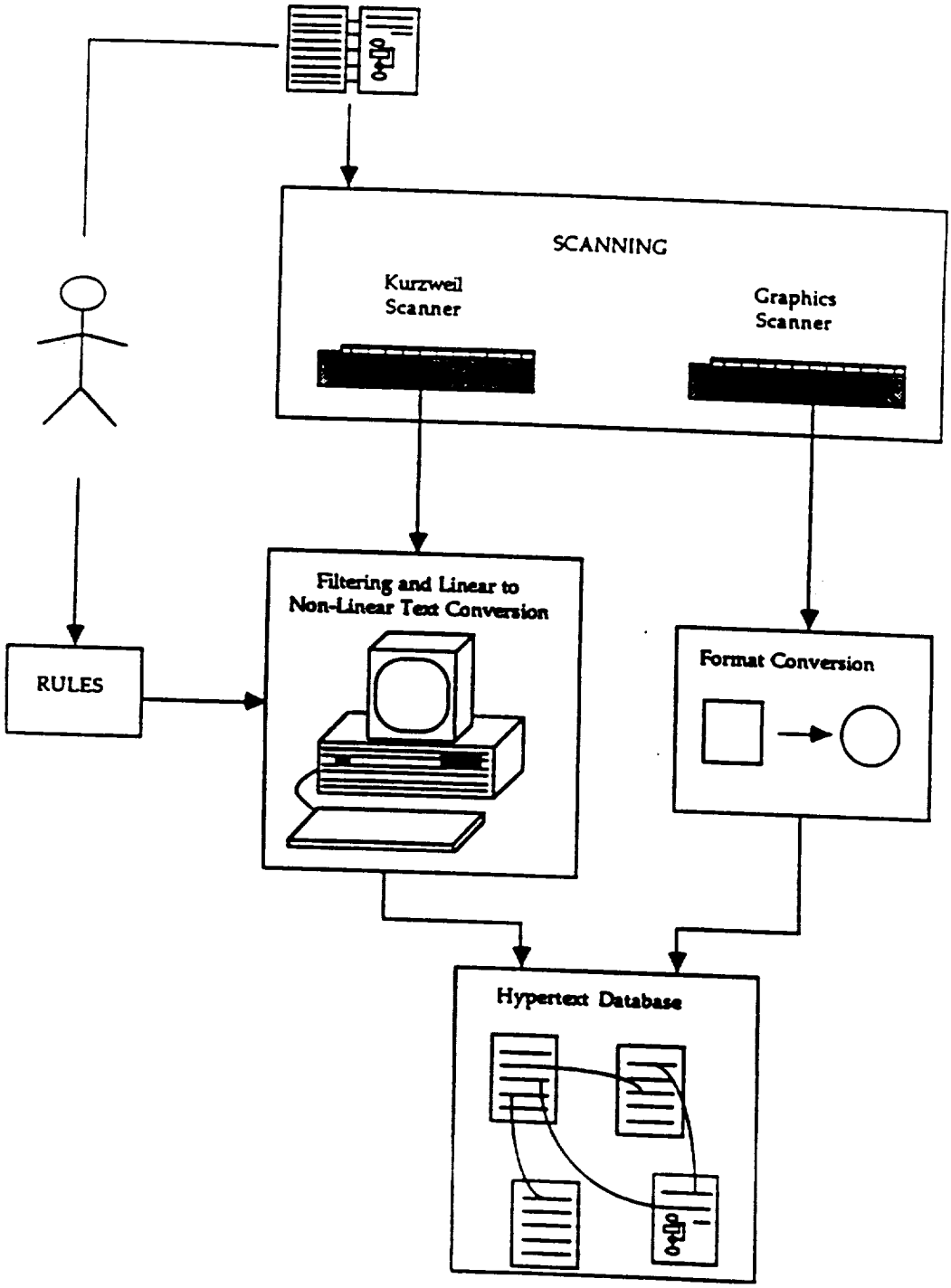
- Introduction
- Rexx Project Overview
- Description of Rexx Manual
- Description of HyperTIES
- Manual Conversion
- Automatic Conversion
- Topology of Rexx HyperTIES Encyclopedia
- Lessons Learned from the Rexx Project
- Reflections on the Rexx Project
- Current and Future Work

Introduction

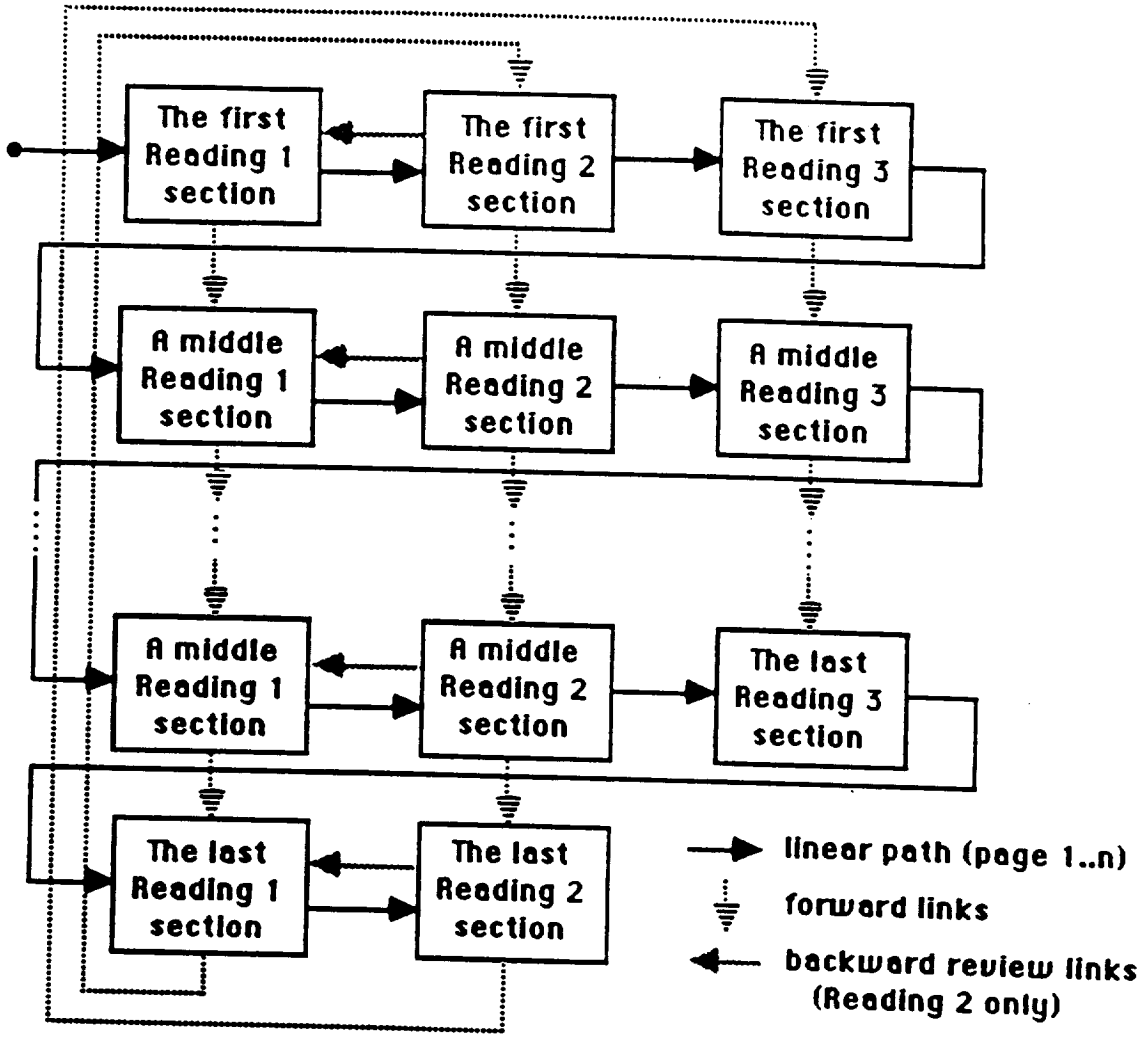
- Most information is currently in linear, paper-based form
- Cost of producing, distributing and maintaining is becoming prohibitive
- Medium is changing from paper to electronic
- Paper may not be an option ... Space Station Documentation
- We are no longer bound by the linear format
- Hypertext is a non-linear medium
- Authors will learn to write non-linearly
- Many dollars are invested in current documentation
- To speed the conversion of massive amounts of linear documentation to non-linear form, we must have an automatic process

- The Rexx project was a case study intended to shed some light on the process and associated problems of converting from a linear, paper-based form into hypertext

Rexx Project Overview



Description of Rexx Manual



Description of HyperTIES

- Hyper - The Interactive Encyclopedia System
- Univ. of Maryland (Ben Shneiderman)
- Encyclopedic hypertext systems - "write once, read-mostly" environments
- Author and Browser are separate
- Nodes: textual (articles) and bit-mapped images (pictures)
- Links: uni-directional, to-links
- Display: small, tiled, paged windows
- Platform: IBM PCs
- Limitations: maximum of 200 articles per encyclopedia
  maximum of 10,500 characters per article

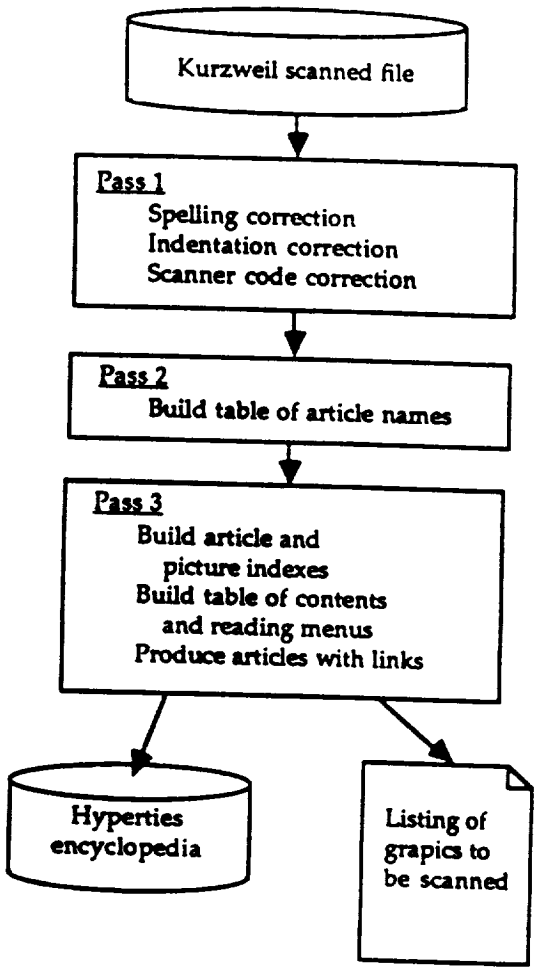
- HyperTIES was chosen as the target hypertext system because of its availability, simple storage design and separate Author and Browser. The output of the automatic conversion program is directly browsable by the HyperTIES Browser.

Manual Conversion

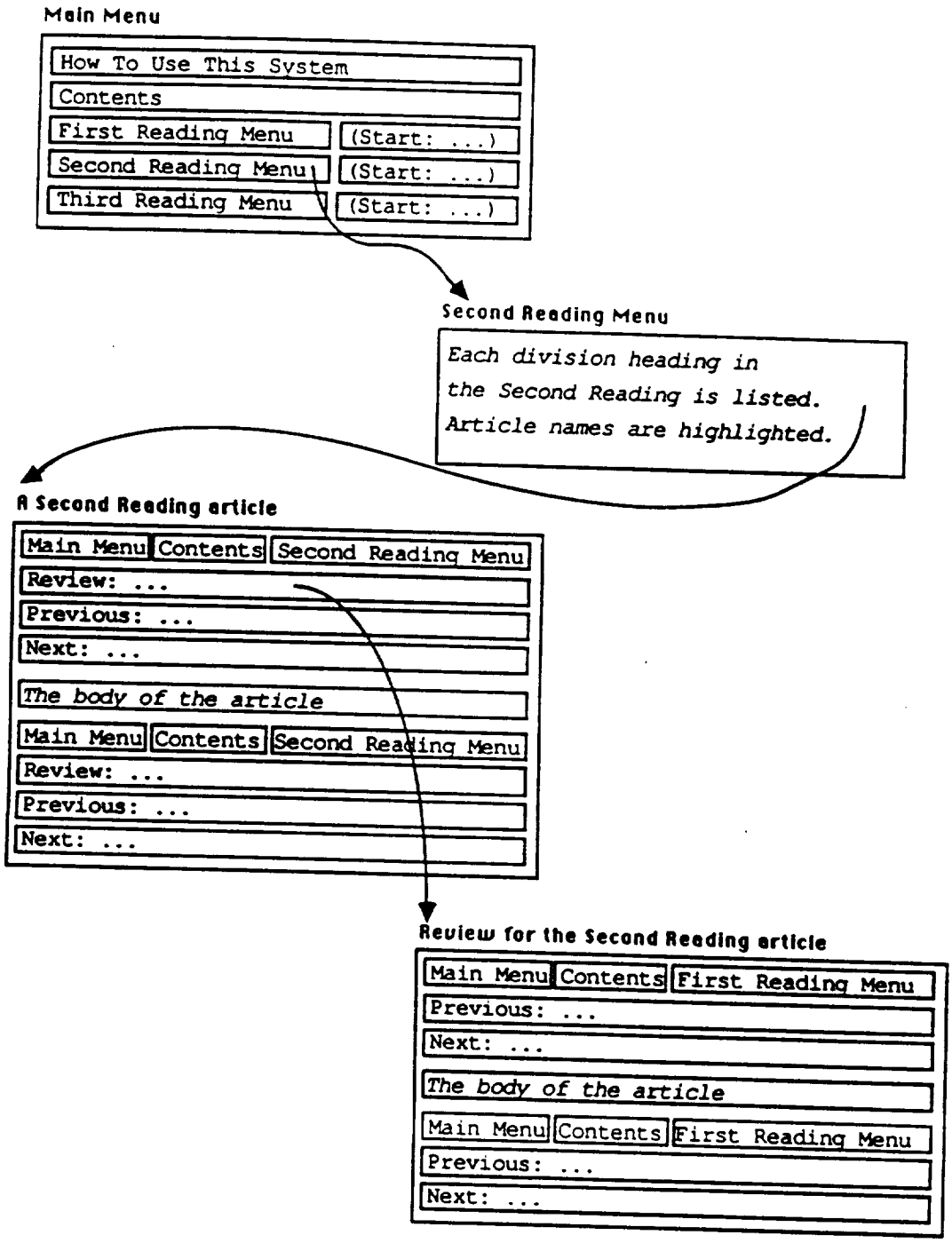
- Why? To generate the rule base used in the automatic conversion
- How? Pasted to wall, colored lines, 7 hours
- Observations
  - Limit on number of articles forced larger granularity (<200 articles)
  - Limit on size of articles (<10,500 characters) forced articles to be split
  - Larger granularity requires into-links
  - Approximately 500 articles would be necessary if we only used to-links
  - A large amount of text in the paper version is irrelevant in a hypertext environment: headers, footers, paper-link instructions, etc.
  - Keyword template matching would work quite well since the manual was written in a regular fashion

- Why did we continue? To see what else could be learned and to verify that a simple keyword template matching algorithm would work

Automatic Conversion



Topology of Rexx HyperTIES Encyclopedia



Lessons Learned from the Rexx Project

- Scanning with Kurzweil 4000
  - Operator is very important
  - Ligatures and kerning
  - Separate graphics scanning
  - Summary: You don't want to do it! (commercial services)

- Rexx manual was probably not a good choice
  - Highly piece-wise linear
  - Already chunked into "small" units

- HyperTIES was probably not a good choice
  - PC/AT platform too slow
  - Display too small (single, paged window)
  - No into-links
  - Limited graphics

- Keyword template matching worked well for this level of conversion

Reflections on the Rexx Project

- Granularity of node size
  Inherent to hypertext construction and hypertext systems in general
  Inherently tied to display techniques

- Into links are a necessity
  Consider keyword index
  Consider granularity of node size

- We forged only explicit structural and explict associational links producing a "linear hypertext" ... i.e., a non-linear text that may be browsed in a non-sequential manner but is almost entirely devoid of higher level semantic links

- Since the information has already been "chunked" for paper, it may have to be "re-chunked" for hypertext

Current and Future Work

- Conversion of a set of manuals into an integrated hypertext
  - Redundancy
  - Appropriate views
- Forging implicit associational links
  - Natural language processing
  - Knowledge-based techniques
  - Usage-driven dynamic links

Considerations for Converting Text into Hypertext

- Inter-Document Considerations
- Intra-Document Considerations
- Structures and Associations
- Context
- Questions
- Issues
- Considerations

Inter-Document Considerations

- Redundancy
  Verbatum - exact or nearly exact repetition
  Granular - same material at different level of detail

- Views
  Each document has its own view, style and intended audience
  Should the same views be retained in the integrated hypertext?
  What other views are appropriate?

- Inter-Document links
  Degree of connectivity

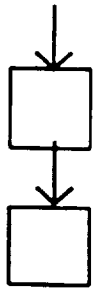
Intra-Document Considerations

- *A priori* assumptions about the reader's path
- Previous references
- Intra-Document links
  Degree of self-referencing
- Chunks that may be read in isolation
- Chunks that may be read in many different paths

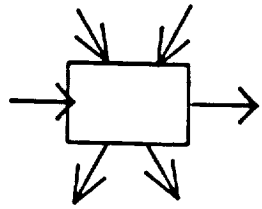
Structures and Associations

- Structures
  Isolation

  Linear



  Non-linear



  Feature extraction: books, chapters, sections, tables of contents, indexes

- Explicit associations
  See X in Y
  Function of writer's style, inclination, knowledge of subject matter
  Environment of document

- Implicit associations
  Higher level semantic associations
  Full text cross references and proximity searches
  Natural language understanding, linguistic techniques
  Usage-based dynamic linking

Context

- Writing is always done in context
- It is a social context most clearly seen in collaboration
- How can we write isolated, context-less chunks?
- An example:
  Q. Do previous references have to be removed?
  A. Not as long as we can distinguish the appropriate context
  Q. How?
  A. Threads: history, main, alternatives

Questions

- How reusable are the modules of text?
- Will the modules fit into different rhetorical contexts?
  Different: approaches, background, reading level?
- Will document quality diminish through reuse of text modules?
- When is hypertext not appropriate?

Issues

- At a minimum, the hypertext version must be as useable as the paper version ... this will be extremely difficult to achieve
- The hypertext version must:
  Allow free annotation
  Allow personalization
  Have the concept of space
  Support user views as well as personal views
- A poor linear document may be even worse when non-linearized

Considerations

- Personality of writer
- The information has already been "chunked" two ways:
  Logically for consumption by the reader
  Physically by any formatting commands and mark-up
- We must understand the various forms of on-line information and the nature of the users of that information

What are we doing, anyway?

- Preliminaries
- Rhetoric of hypertext
- What must we understand to do it right?
- We should probably rewrite

Preliminaries

- What is hypertext?
  "Non-linear writing" and
  " ... a body of written or pictoral material interconnected in such a complex way that it could not conveniently be presented or represented on paper." [Ted Nelson 1965]*
- Bush vs. Nelson
- On-line documentation vs. hypertext
- Q. If you have converted into a "hypertext" system whose major emphasis is paper ... have you converted into hypertext?
- Q. What do we want?
  A. Hypertext
  Q. Why?
  A. It is the only technology that can come close to making on-line documentation as good as paper documentation ...
- We currently have an inadequate conceptual model upon which to build text to hypertext conversion programs

* Nelson, T. H. 1965. A file structure for the complex, the changing and the indeterminate. *Proceedings of the ACM 20th National Conference.*

Rhetoric of hypertext

- Rhetoric: the theory and practice of effective communication
- We don't even know how to display linear sequences so that they are easily read
- Style always begins with the medium, and we currently don't understand the medium
- We have no rhetoric for hypertext ... how can we write (translate) effectively?
- Composing in hyperspace requires the concurrent design of nodes, links and environment
- We must understand how to read hypertext before we can write hypertext

What must we understand to do it right?

- The various styles of documentation
- The various styles of hypertext
- How to read non-linearly
- How to write non-linearly
  How technical writers write non-linearly
- How to display non-linear writing of various styles
- The concept of space
  Coffee stains on well-used pages, personalization, annotations ...

We should probably rewrite

- "We live in the rear-view mirror." [Marshall McLuhan 1969]
- We use new technology to do what we did yesterday ...
- New technologies/old methodologies

DONA ERB

Prototype Job Performance Assistance for On-Board Space Station

HYPERCARD PROTOTYPE OF JOB PERFORMANCE ASSISTANCE FOR ONBOARD SPACE STATION

Hypermedia '88 Conference
Houston, Texas
September 14-15, 1988

Dona M. Erb
The MITRE Corporation

TOPICS TO BE PRESENTED

- Onboard Space Station Training
- Job Performance Assistance (JPA) mode
- Hypermedia Prototype Implementation of JPA

ONBOARD SPACE STATION TRAINING

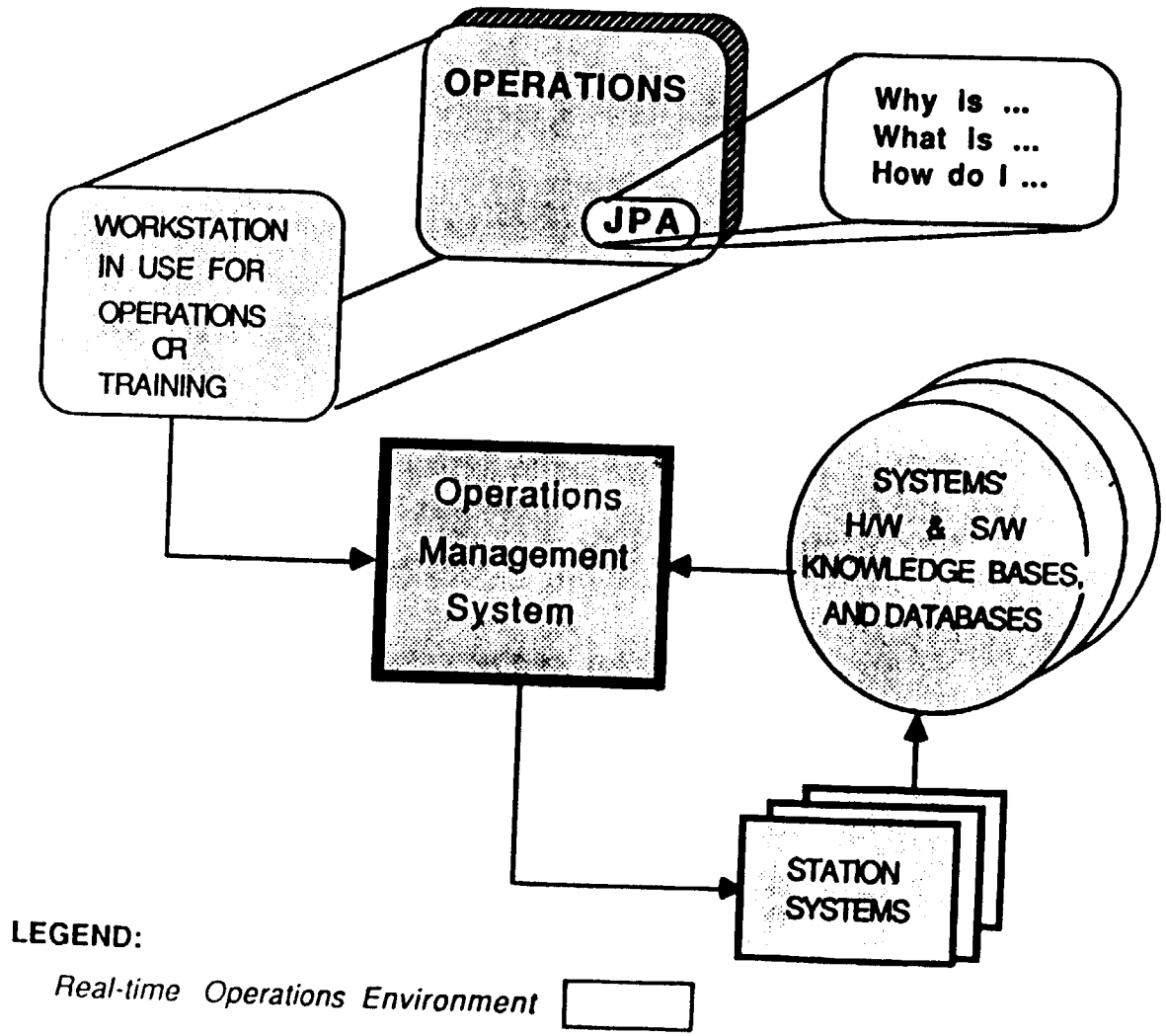
- Need for onboard training
  - -- Space Station will be complex
  - -- Space Station will change/evolve
  - -- Few crewpersons for many tasks
  - -- Humans have limitations

- Kinds of onboard training
  - -- CAI
  - -- Simulations
  - -- Job Performance Assistance (JPA)

J P A MODE OF TRAINING

- What is JPA used for?
  - -- Refreshing previously learned information
  - -- Learning new or changed information
  - -- "Just-in-time" training for low probability events
- How would JPA facilitate real-time operations?
  - -- Support user of Operations Management System
  - -- Assist command and monitoring of systems, including payloads
  - -- Provide procedures in text, video and audio for maintenance activities

JPA MODE OF TRAINING



MITRE

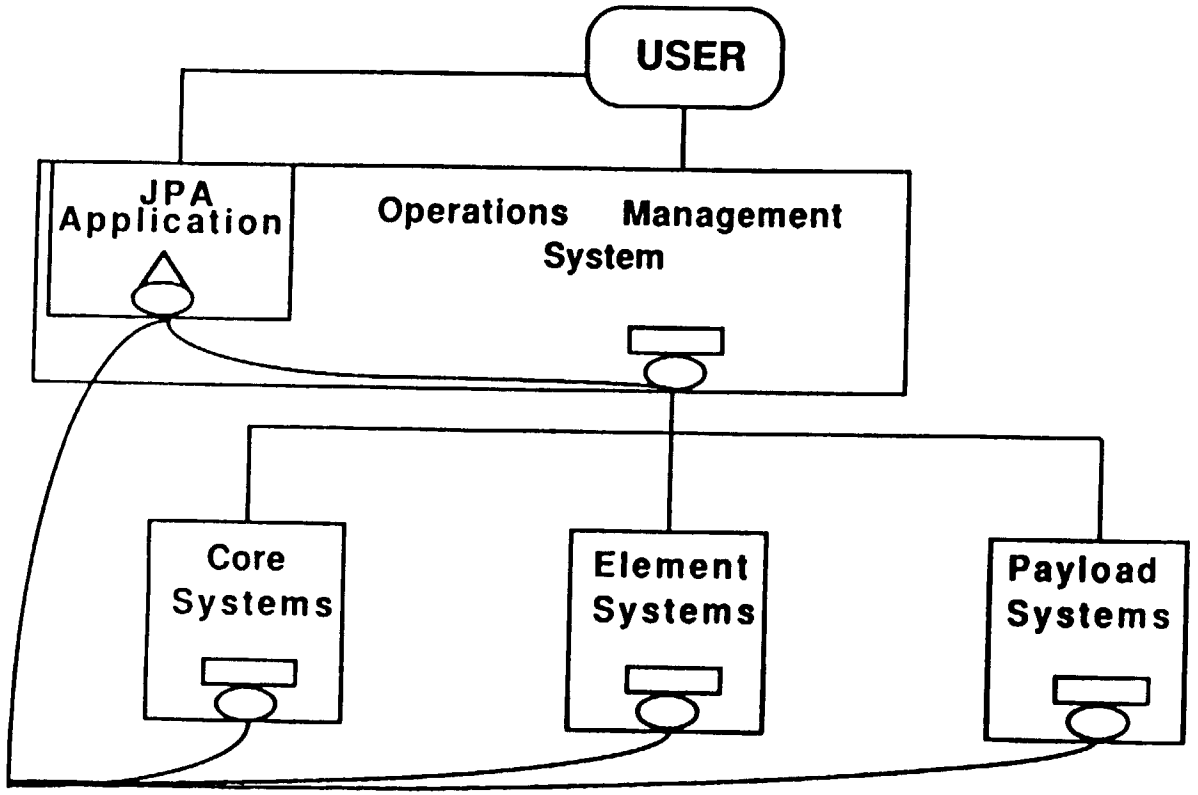
ATTRIBUTES OF J P A MODE OF TRAINING

- Help is accessible at any point during real-time operations via the Operations Management Application
- Accurate, consistent and current information is provided
- Initial information is consistent in reading level, scope and length
- Detailed information is available rapidly
- Tendency to passive use of automated systems is reduced

IMPLEMENTATION CONSIDERATIONS FOR JOB PERFORMANCE ASSISTANCE

- Mode of initiation of assistance
  - -- User-reactive
  - -- User-responsive
- Ease of maintenance and enhancement
- Alternate implementations of instruction
  - -- Embedded within system code
  - -- As a shell around system code
  - -- As a separate task in a multi-task environment
- Common interface

JPA MULTI-TASK



Legend:

System Code ▭ JPA Code △ Knowledge Bases ⬭

MITRE

HYPERMEDIA PROTOTYPE IMPLEMENTATION OF J P A

- GUIDE, Hyperties and HyperCard considered for prototype

- HyperCard selected

  -- Same rhythm as other Macintosh interfaces

  -- Considerable programming aids and examples, although limited documentation at the time

  -- Flexible link creation via "buttons"

  -- Support for importation of illustrations

  -- Special routines available from user-community

HYPERCARD'S* BUILDING BLOCKS

- *Stacks* are sets of *cards*

- *Cards*

  -- Contain text or graphics
  -- Have two layers
     --- *Background* layer is for multiple-use formats

  -- May contain *buttons* and *fields*
     --- *Fields* are windows for text or illustrations
     --- *Buttons* are mouse-sensitive areas with attached instructions

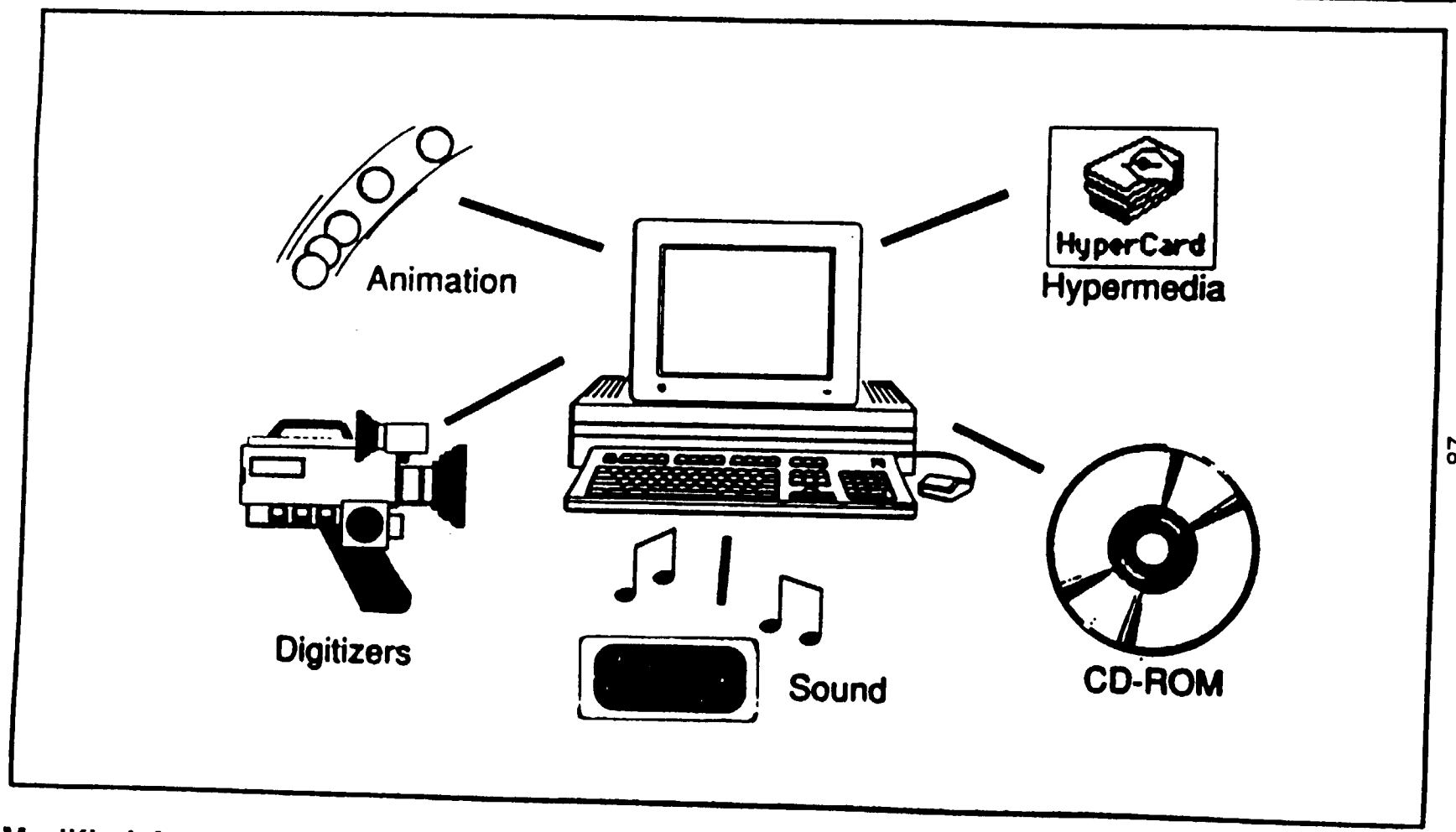
- *Scripts* are program instructions written in HyperTalk*

* Registered trademark of Apple Computer, Inc.

NAVIGATIONAL CONTROL

- Cueing the user (kinds of links)
  - -- How to get home and to the last bookmark
  - -- When more detail is available
  - -- When associated information is available
- Visual cues with icons
  - -- Arrows, magnifying glass, special fonts
- Visual effects
  - -- Slideshow, barndoor, zoom

INTEGRATION OF MULTIMEDIA* WITH HYPERCARD



*Modified from Connie Guglielmo, MacWEEK May 31, 1988

MITRE

IMPLEMENTATION OF MULTIMEDIA

- Use of scanner

  -- Thunderscan scanner outputs McPaint document
  -- SuperPaint or McPaint graphics clean up
  -- HyperCard import capability transfers graphics to card
  -- HyperCard paint tools support touchup and scaling

- Use of audio

  -- Macintosh SE internal synthesizer
  -- Talk and Speak external commands

HYPERCARD AS A HYPERMEDIA TOOL

- Developer support increasing

  -- More free stacks available to use for examples
  -- More "how to" books available
  --- Especially needed for custom external commands and functions

- Apple, third party vendors, and users enhancing HyperCard capabilities

  -- Drivers for interfaces to interactive videodisc, CD ROM, audio
  -- Animation drivers
  -- Complex text import systems
  -- Sound and video digitizers

HYPERMEDIA CAUTIONS

- Memory requirements will be very demanding for JPA
- Large hypermedia system development may need front-end tool
  - -- Designer/developer and user could all get "lost in space"
- User-instigated searches must have access to all information
  - -- HyperCard *Find* command doesn't search outside originating stack

SUMMARY

- Limits of human memory need not compromise efficient operation of Space Station
- JPA can provide OMS support
- Common JPA interface should be utilized
- System knowledge bases may be a resource for JPA
- Good hypermedia tools are already commercially available

CHRIS DEDE

The Four Great Problems of Hypermedia-- and Their Solutions

The Four Great Problems of Hypermedia -- And Their Solutions!

Research Summary

Presented by Chris Dede

September, 1988

Four Great Problems of Hypermedia

FOCUS: Evolution of Hypermedia as a Knowledge Representation

- data --> information --> knowledge --> wisdom
- new electronic approaches to knowledge creation, capture, transfer, and utilization
- Factors Shaping the Evolution of Electronic Documentation Systems (RICIS - 1/88)

By anticipating changes, can facilitate an orderly progression of increasingly sophisticated strategies

Four Great Problems of Hypermedia

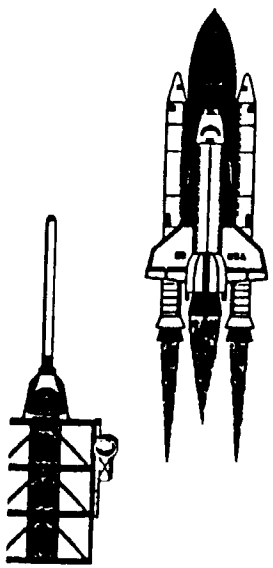
OPERATIONAL CHALLENGES

First Generation: **limited link types**
limited multi-media capabilities
lack of browsers

Fundamental: **user disorientation**
cognitive overhead
combinatorial explosion
collective communications problems

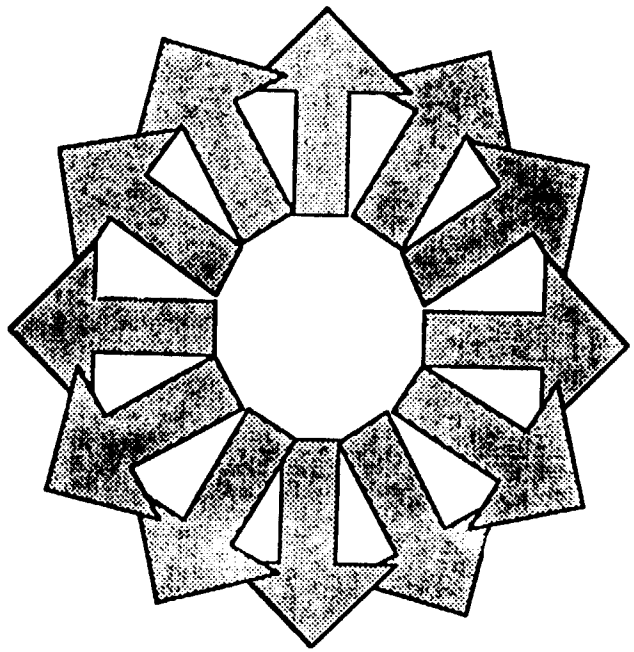
Four Great Problems of Hypermedia

THE SECRET OF TRANSMUTING LEAD INTO *GOLD*



Four Great Problems of Hypermedia

THE *SOLUTION* TO FERMAT'S LAST THEOREM



$$A^n + B^n \neq C^n \qquad \text{for } n > 2$$

Four Great Problems of Hypermedia

USER DISORIENTATION

- Determining location in the network
- Establishing directions for movement
- Blazing a trail of scanned material
- Developing non-hierarchical referencing systems

Four Great Problems of Hypermedia

COGNITIVE OVERHEAD

» Making choices among alternative branches

» Keeping track of orientation

» Linking new information to existing webs

» Coping with multiple representational ecologies

Intellectual Indigestion, Cognitive Entropy

Four Great Problems of Hypermedia

COMBINATORIAL EXPLOSION

Extremes of Interconnectedness

- type of knowledge stored
- objectives of documentation
- sophistication of users

Multiple Dimensions of Hierarchies

Four Great Problems of Hypermedia

COLLECTIVE COMMUNICATIONS PROBLEMS

» Modifications in collegial knowledge bases

» Vanishing and invisible nodes, links, trails

» "intuitively obvious" connections

"Tower of Babel" problems

Four Great Problems of Hypermedia

THE PROMISE OF HYPERMEDIA

A "KNOWLEDGE MEDIUM"

TAILORING COGNITIVE EVOLUTION

MIMETIC MANIPULATION

PAUL KAHN

Intermedia: Fundamentals of a Model Hypermedia Environment

Historical Models 1

- **Early Printed Books**

Nuremburg Chronicle:
Transition of text and graphics from manuscript to printed book

Johan Comenius:
Linking of text and graphics for teaching

Historical Models 2

- **Bush's Memex (1945)**

"The human mind ... operates by association"

Links and trails

Analog computer model

Historical Models 3

- **Nelson's Xanadu (1965-)**

Hypertext: non-sequential writing

Parallel text

Links and connections

Docuverse of all knowledge

Historical Models 4

- **Engelbart's NLS (1968-)**

"Augmenting human intelligence"

idea processing

pointing device

group work

structured documents

linking ideas

Historical Models 5

- **Brown Experiments (van Dam, et al)**

HES (1967)

FRESS (1976)

"Electronic Book" (1980)

BALSA (1983)

Intermedia (1985-)

- **Operating System Functions**

Multiuser

Multitasking

Network support for group access

Network File System (NFS) support

Separate read/write/annotate permissions

- **Use Object-Oriented Programming**

Create applications from shared building blocks

text building block

graphics building block

table building block

- **Integrated Applications for diverse media**

Single graphic user interface

Media-specific document model

text scroll

graphic object

video frame/sequence

audio bite

- **Display of multiple overlapping document windows**

Maintain visual context when following links

Integration of text, graphics, video, animation, audio, etc.

- Persistent linking of selections

Copy and paste model

Modeless operation

Interactive authoring

Application specific selections

Linking Model 1

- **Block to block**

Block is any selection

Links are untyped

Links are bidirectional

Many links can connect a block

Linking Model 2

- **Links are unobtrusive**

Links do not destroy document integrity

Blocks and links appear as an overlay on document display

Linking Model 3

- **Store links separate from documents**

Block and link information stored as tables in Relational DBMS

Associate properties with links

User name

Time/Date stamp

Explainer

Linking Model 4

- **Collect links in Webs**

Web is the context of a set of links

Documents can appear in any number of webs

Hypermedia Bibliography

This bibliography has been compiled an edited by the staff of the Institute for Information and Scholarship (IRIS) at Brown University. It is distributed as a service to the hypermedia research community. Please send any corrections, suggestions for additions, or comments to: Nicole Yankelovich, Project Coordinator, IRIS, Brown University, Box 1946, Providence RI 02912 (e-mail: ny@iris.brown.edu).

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JOHN SLATIN

Toward a Rhetoric for Hypermedia

TOWARD A RHETORIC FOR HYPERTEXT

John Slatin

TOWARD A RHETORIC FOR HYPERTEXT

John Slatin

The order of things: creating traditional text

- The function of rhetoric in a traditional text environment
- The text environment
- Assumptions about reading
  - Reading is sequential
  - Reading is predictive
    - Micro-level predictability
    - Macro-level predictability
    - Meta-level predictability (hypertext)
- Assumptions about writing
  - The end product: the text as closed system
  - Sequence
  - Attitude toward technology

TOWARD A RHETORIC FOR HYPERTEXT

John Slatin

Only connect: creating hypertext (1)

The function of rhetoric in the hypertext environment

The hypertext environment

Assumptions about reading

Reading is non-sequential and associative

Reading as navigation

The reader in hypertext

The reader as browser

The reader as user

The reader as co-author

TOWARD A RHETORIC FOR HYPERTEXT

John Slatin

Only connect: creating hypertext (2)

- Assumptions about writing and composing
  - Authoring
  - The end product: hypertext as open system
  - Linkage is king
    - Nodes and links
      - Nodes
      - Links
  - Predictability
    - Macro-level predictions
    - Micro-level predictions
    - Meta-level predictions
  - Attitude toward technology

DAVID AUTY

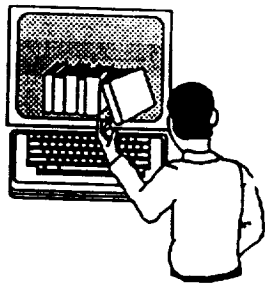
The Use of Hypertext in Software Engineering Applications

The Use of Hypertext In Software Engineering Applications

Overview

- Introduction [our perspective]
- Discussion of an encyclopedic reference guide
- Discussion of use in software development
- Summary

Our View of Hypertext



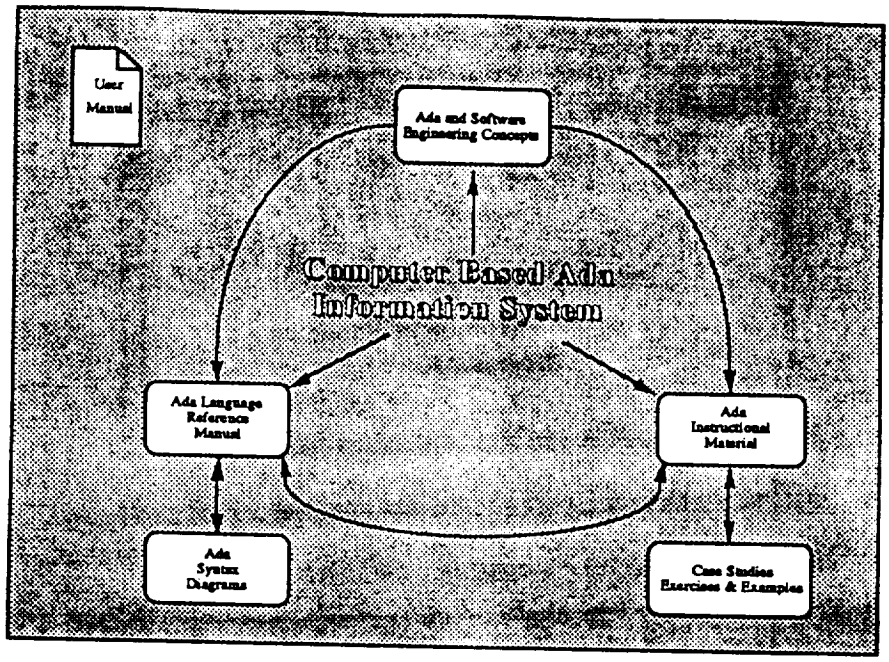
- Hypertext is a means to automating information retrieval
- Hypertext is a means to dealing with large documentation systems

Our View of Hypertext (Cont.)

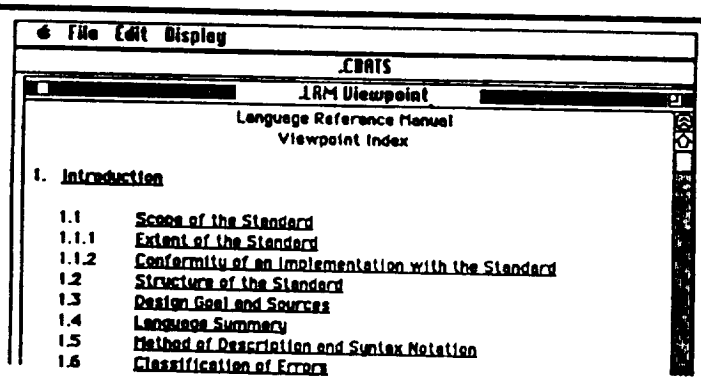
- Typical application is derived from traditional documentation system
- Often involves the capture and linking of existing linear works
- Information architecture is static and relatively simple
- Goal is to make desirable access practical and convenient

Computer Based Ada Information System

- Personal Computer based Ada Reference source
- Built on Ada Language Reference Manual, Ada training course slides, case studies & exercises
- Simplistic model of reference links

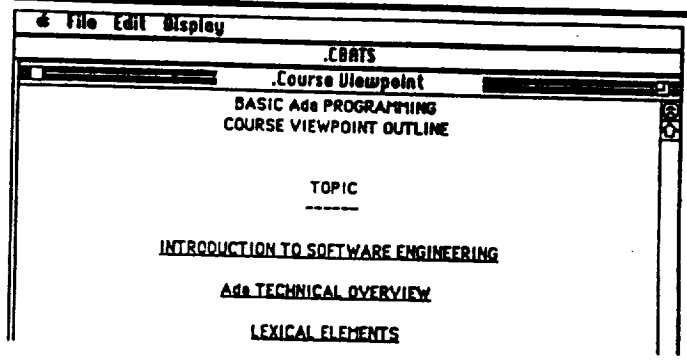


LRM Viewpoint



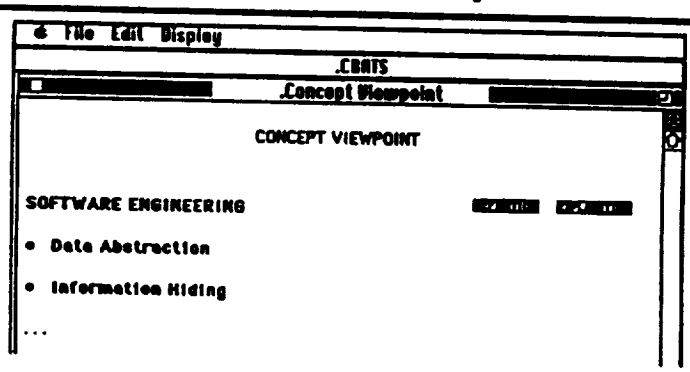
- **Complete copy of Mil-Std-1815A**
- **An authoritative, but sometimes obscure source**
- **Includes links to other expository material**

Course Viewpoint



- First Introduction to Ada training material
- Includes discussion of rational and examples of use
- Not as complete or concise as LRM

Conceptual Viewpoint



- Provides an outline of key software engineering concepts
- Cross-references concepts to language features and course material

Why Hypertext?

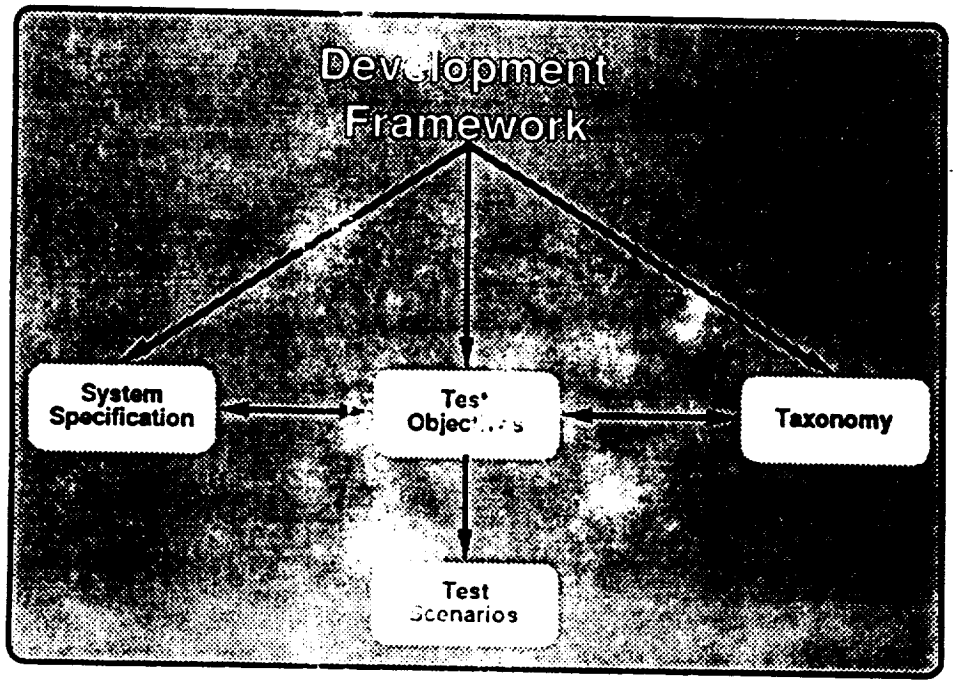
- Reference material is easily accessed
- Cross-references simplify gaining more depth from material

Software Development Conceptual Framework

- **A structural foundation for design and development**
- **Hypertext utilized to implement a design database**

Project Overview

- The system will serve as a software validation test suite
- Each service is tested for compliance with the specification
- An enormous test set if it is to be comprehensive and complete (thousands of test cases)



Overview of Framework

- Provides a cross-reference linking between several views of project:
  - the system specification
  - a taxonomy of functional elements
  - a list of test objectives
  - a list of test scenarios
- Supports the traceability between system requirements and design elements

Why Hypertext?

- Hypertext provides a convenient, document-based cross-referencing approach
- Hypertext allows reasonable database access
- No requirement for database retrieval, report and search capabilities

Why Hypertext? (cont.)

Hypertext serves as a design database capturing:

- design development,
- requirements tracing,
- other design relationships.

Summary

CBAIS and the Framework represent two different uses of hypertext:

a) encyclopedic reference tool

b) design database tool

Both are important to Software Engineering

Lessons Learned

- Authoring Support
- Readership Support
- Hypertext Information System management

Authoring Support

The Current Construction Process:

- Used Guide™ on Macintosh (to be ported to PC)
- Copied in text files, scanned through text, manually linked segments
- Created graphics, pasted them in
- Process was very labor intensive, little support for automation

Authoring Support (cont.)

Building Hypertext:

- Often involves linking existing linear works
- Involves easily recognized patterns of linking in a static architecture
- Needs support to automate the establishment of such links

Reading Hypertext

A clear and simple model of the information web is needed

- to guide reader
- to avoid getting lost in "hyperspace"

Managing the system

- Information Systems should not be considered static
- Evolution can be due to:
  - Initial development progress
  - Revisions after primary development
- Evolution can be in terms of:
  - The document contents,
  - The relationships and links between linear segments
  - The underlying database, e.g. internal names and organization

The Future

- The advent of PC based Hypertext systems significantly expands its potential
- Wide market exits for encyclopedic approaches
- Design database approach is valuable for many software development efforts.

ANDY BURGER

A Virtual Notebook for Collaboration in Biomedical Work Groups

A VIRTUAL NOTEBOOK FOR COLLABORATION IN BIOMEDICAL WORKGROUPS

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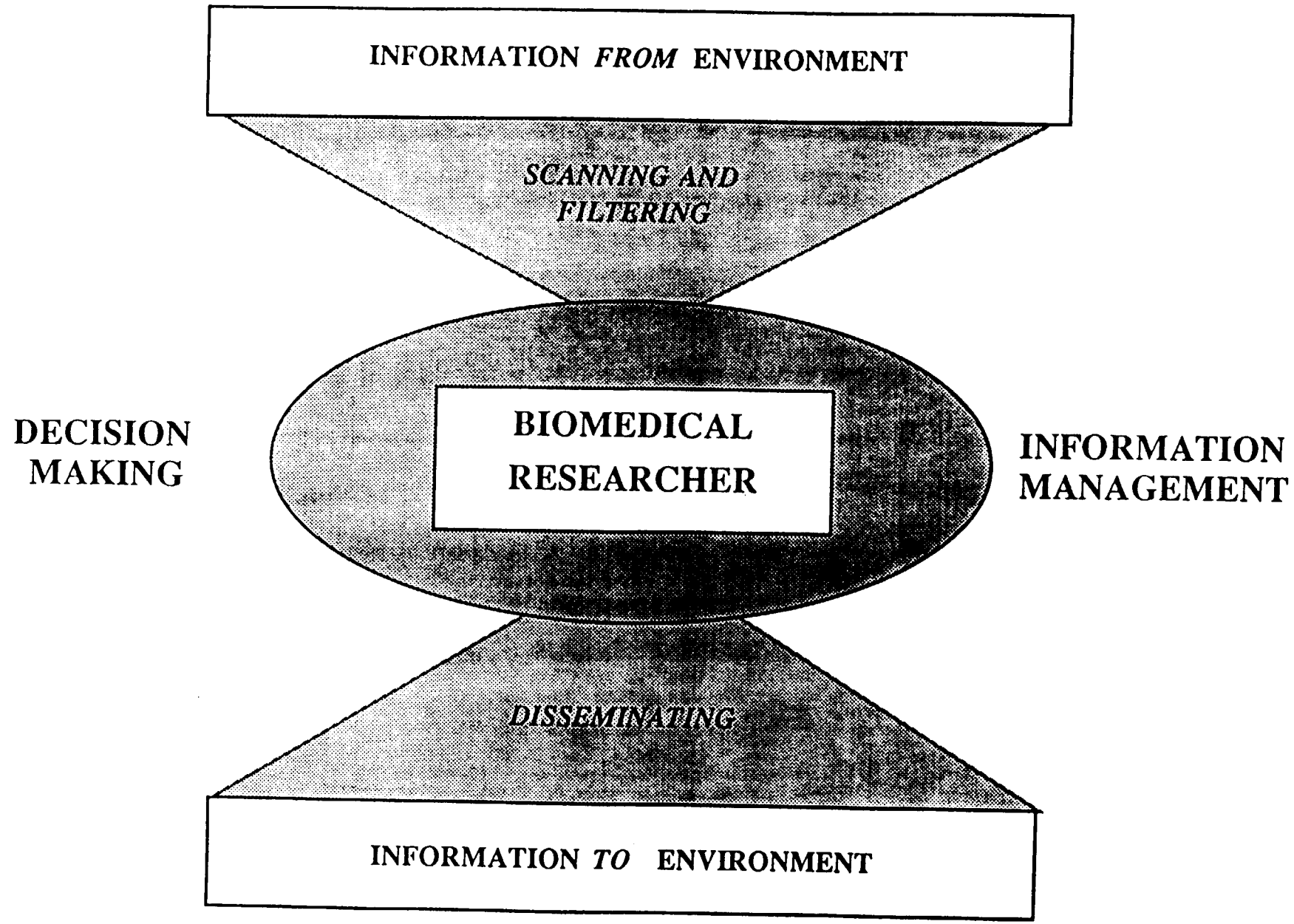
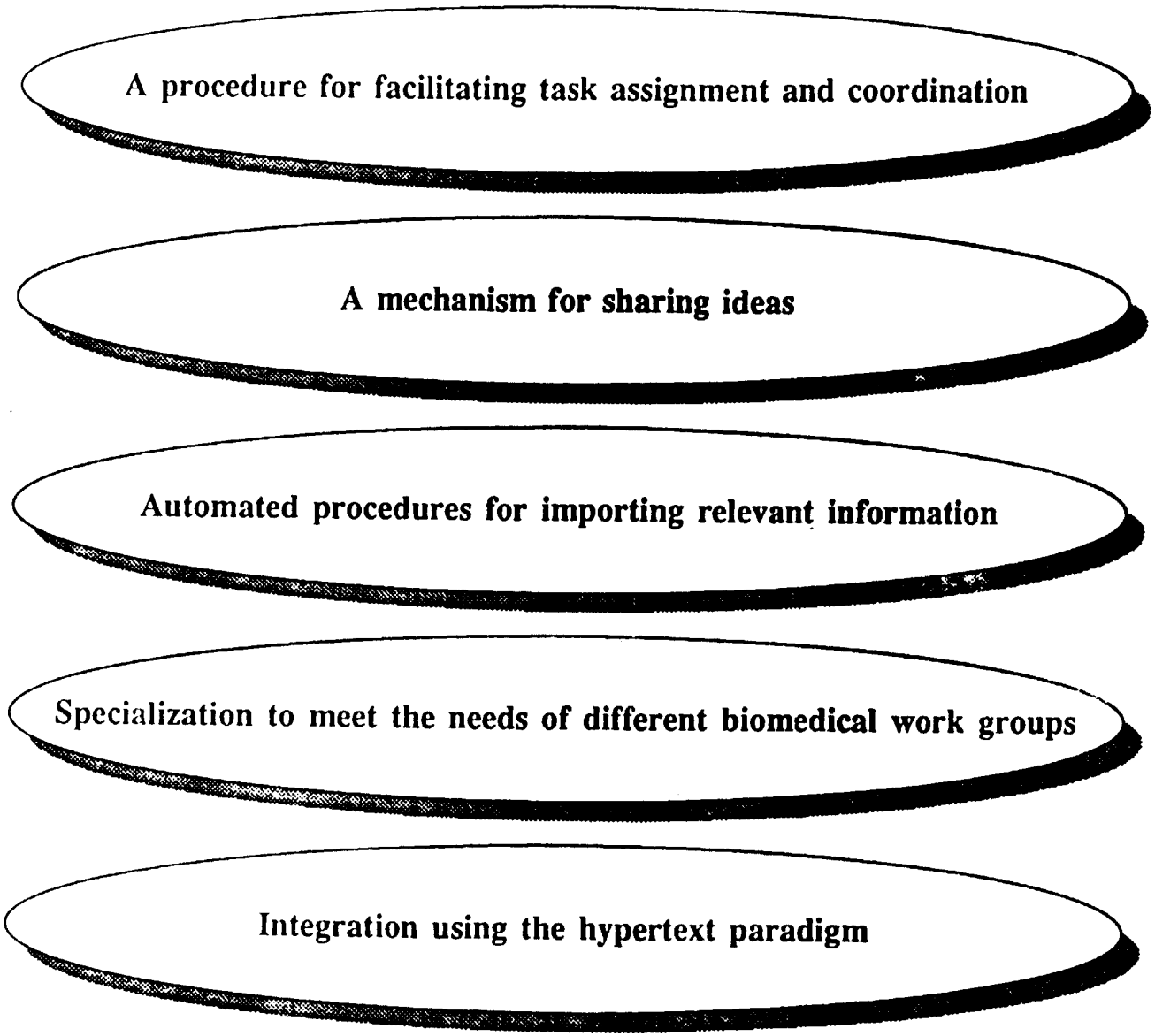
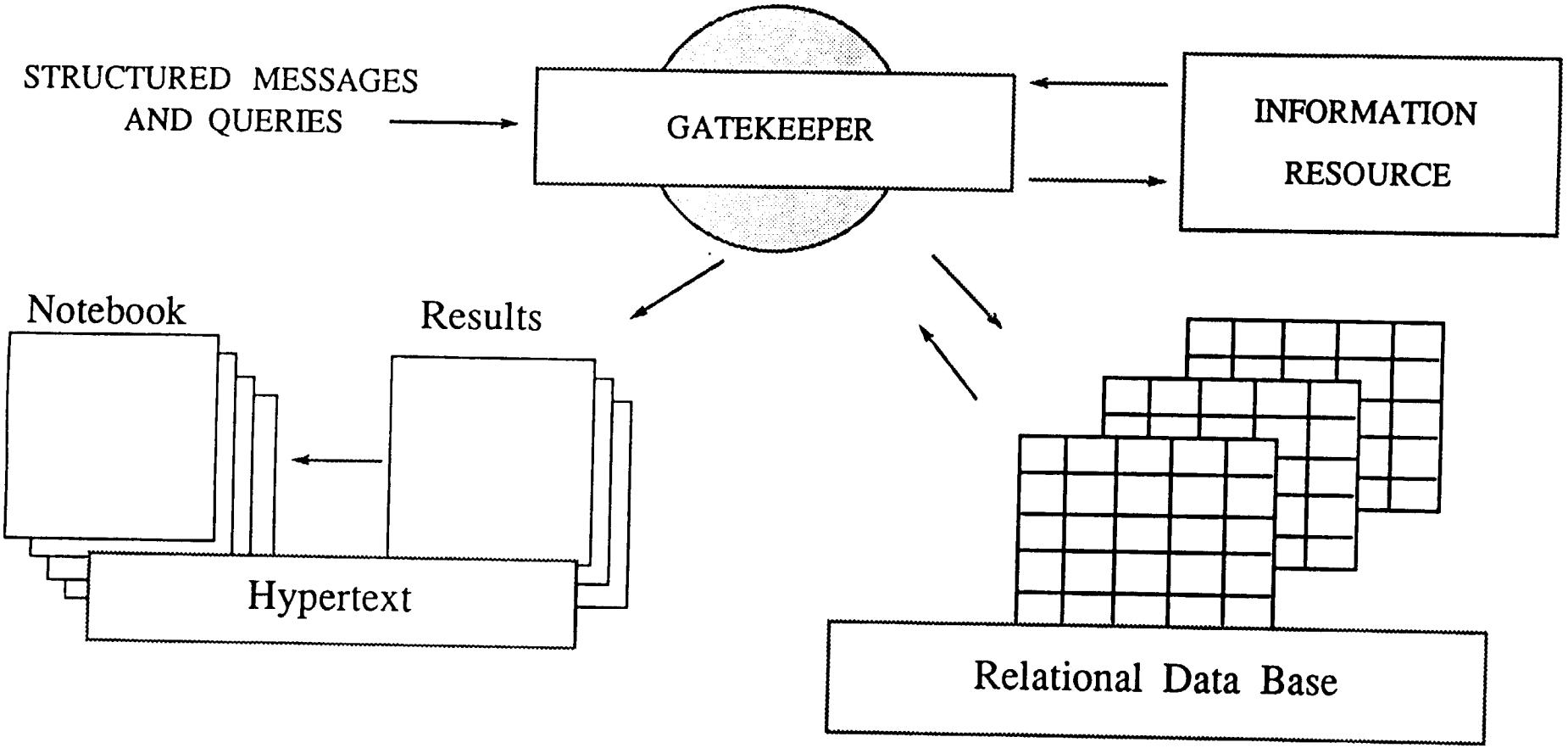


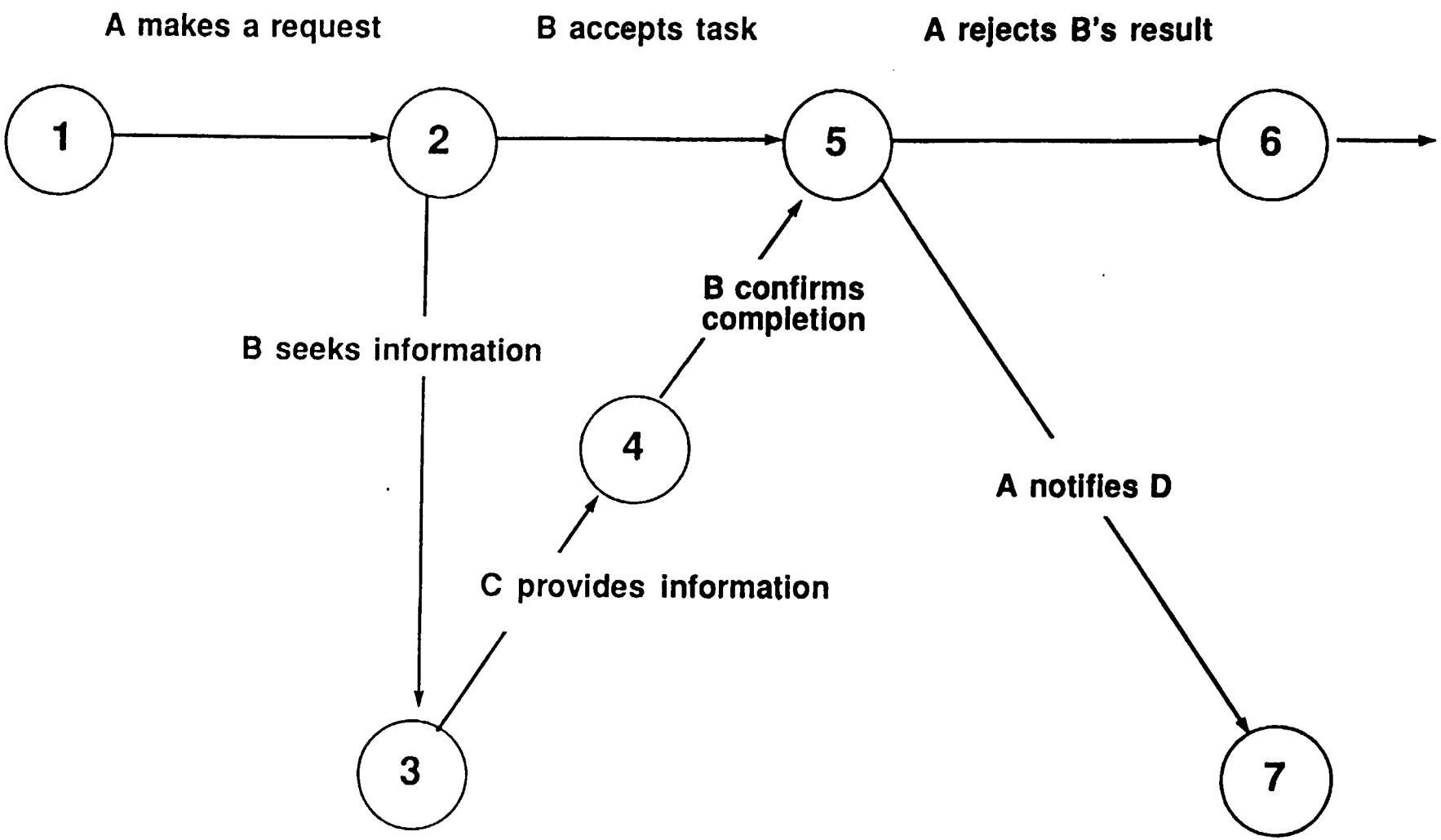
An Information-Processing Model of Biomedical Research



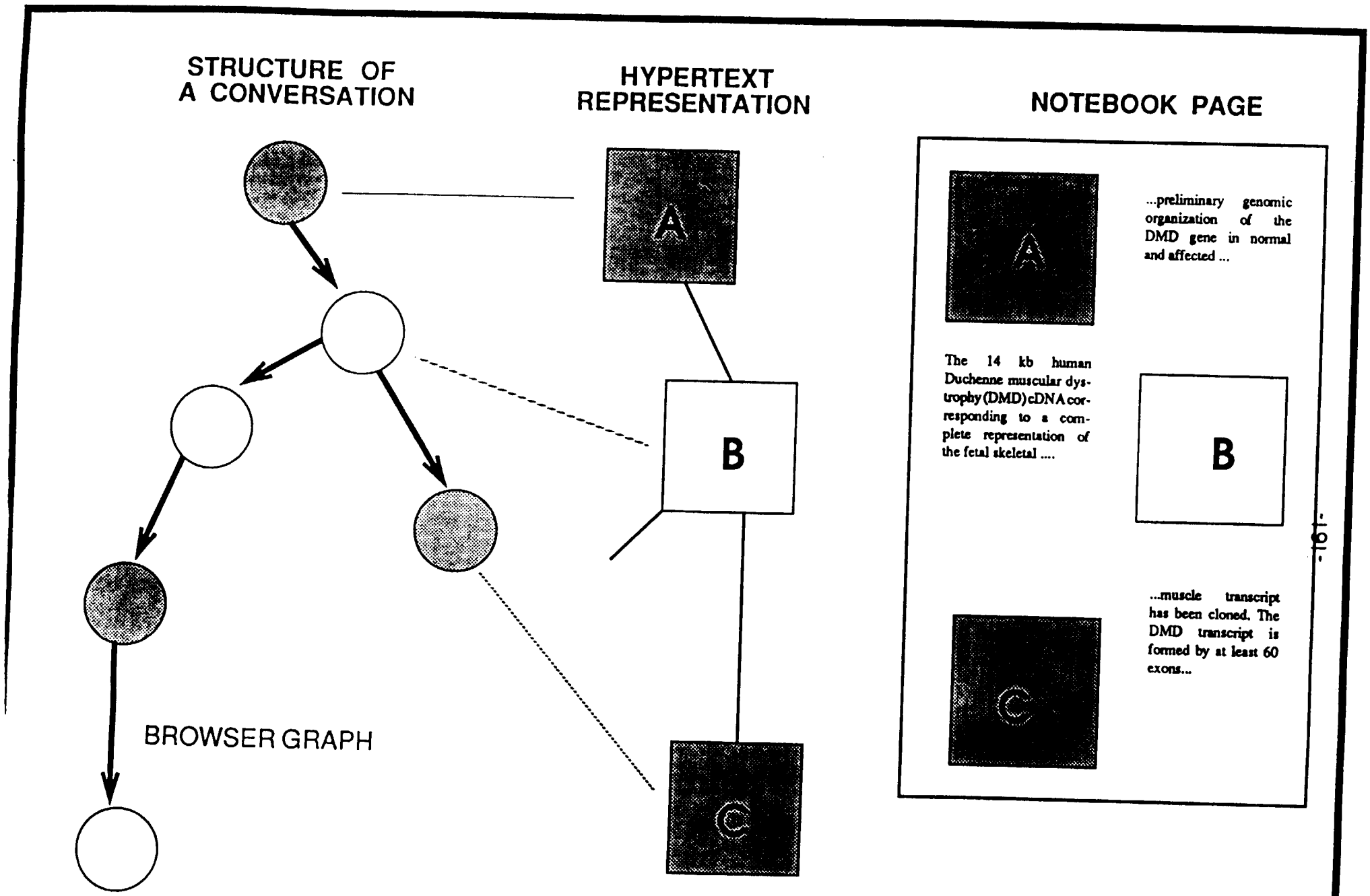
Principal Features of the Virtual Notebook



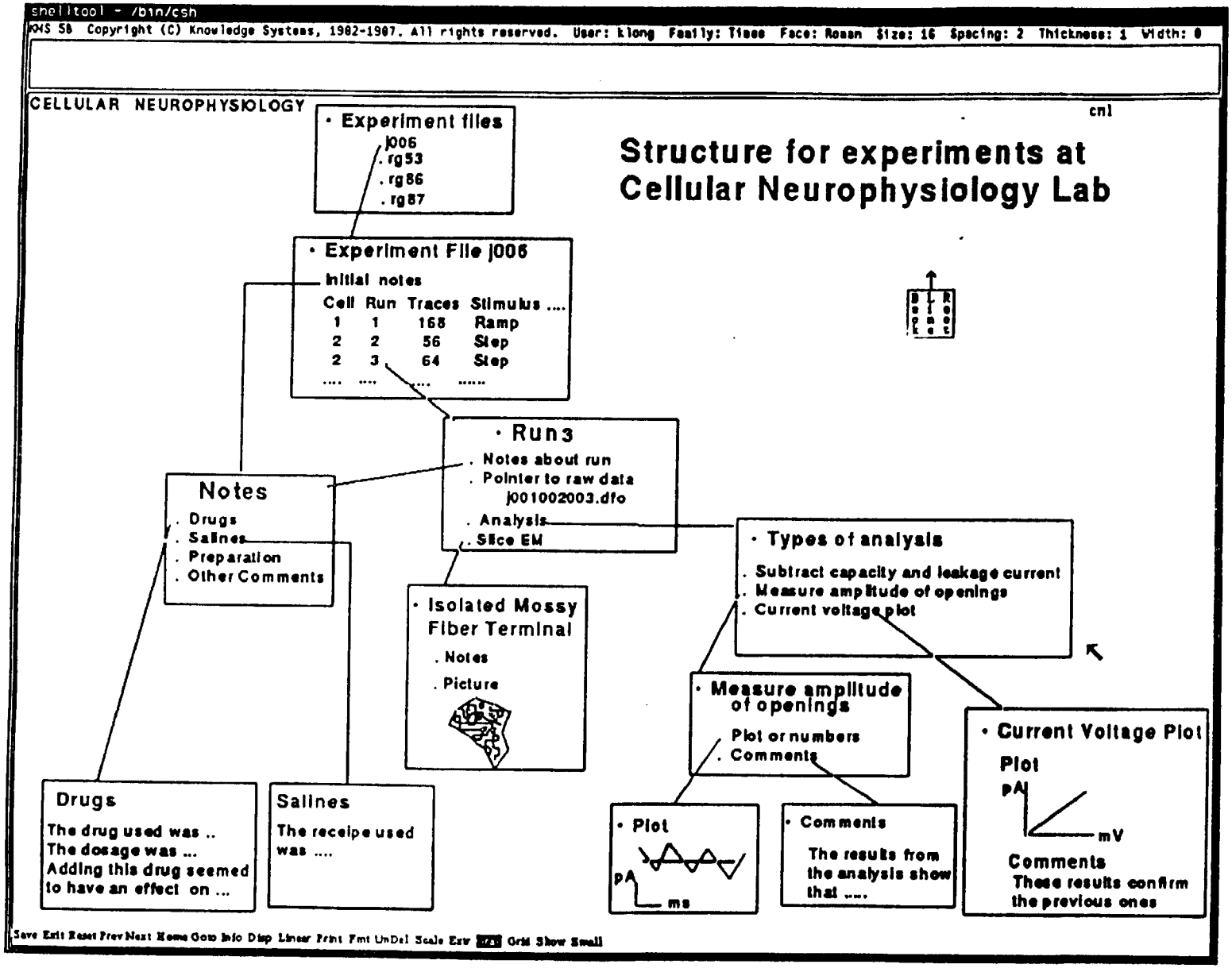
The Elements of the Virtual Notebook



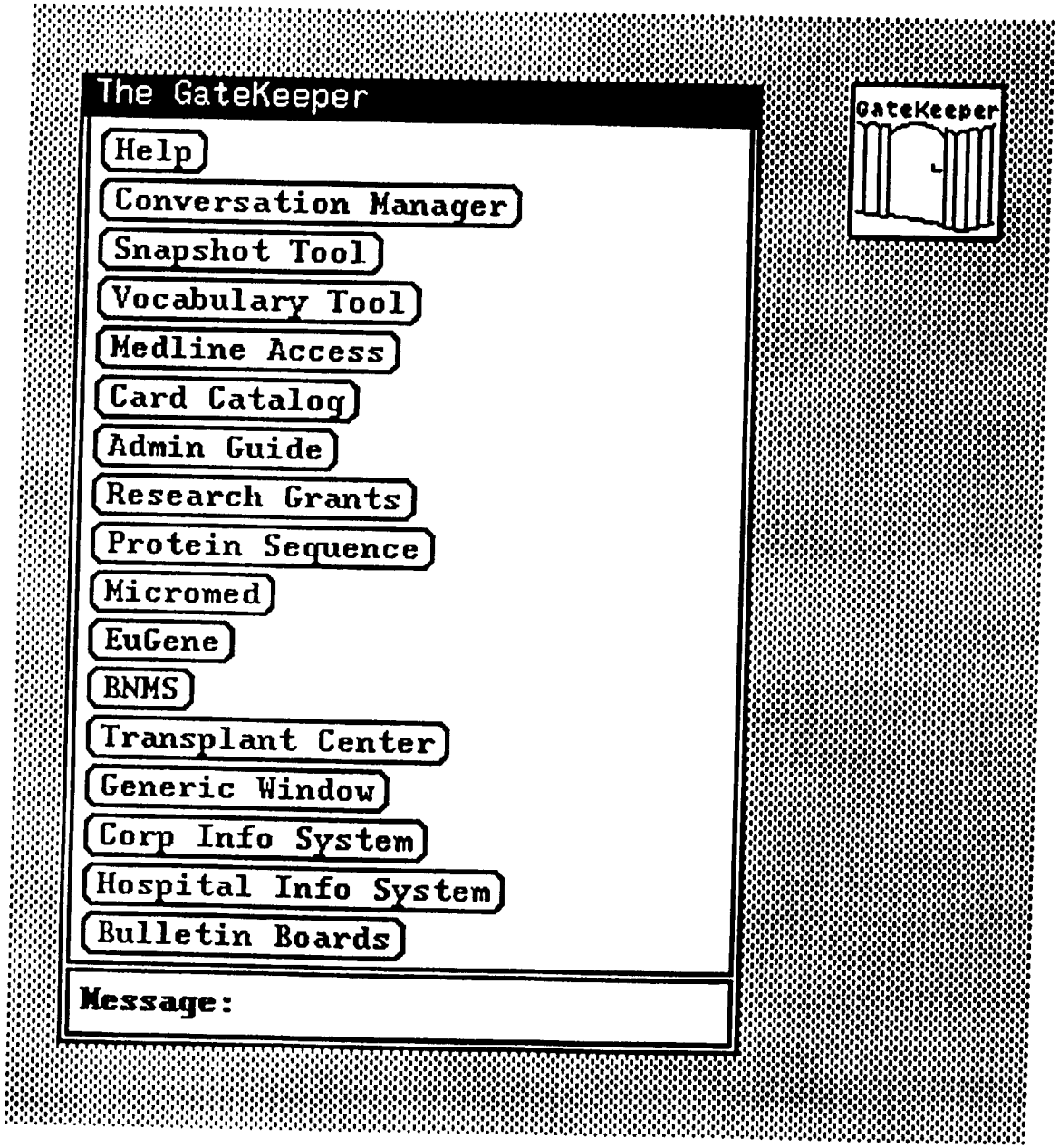
A Conversation for Action



Conversations in the Virtual Notebook



A Notebook Page for Cellular Neurophysiology


The GateKeeper
GateKeeper
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Conversation Manager
Snapshot Tool
Vocabulary Tool
Medline Access
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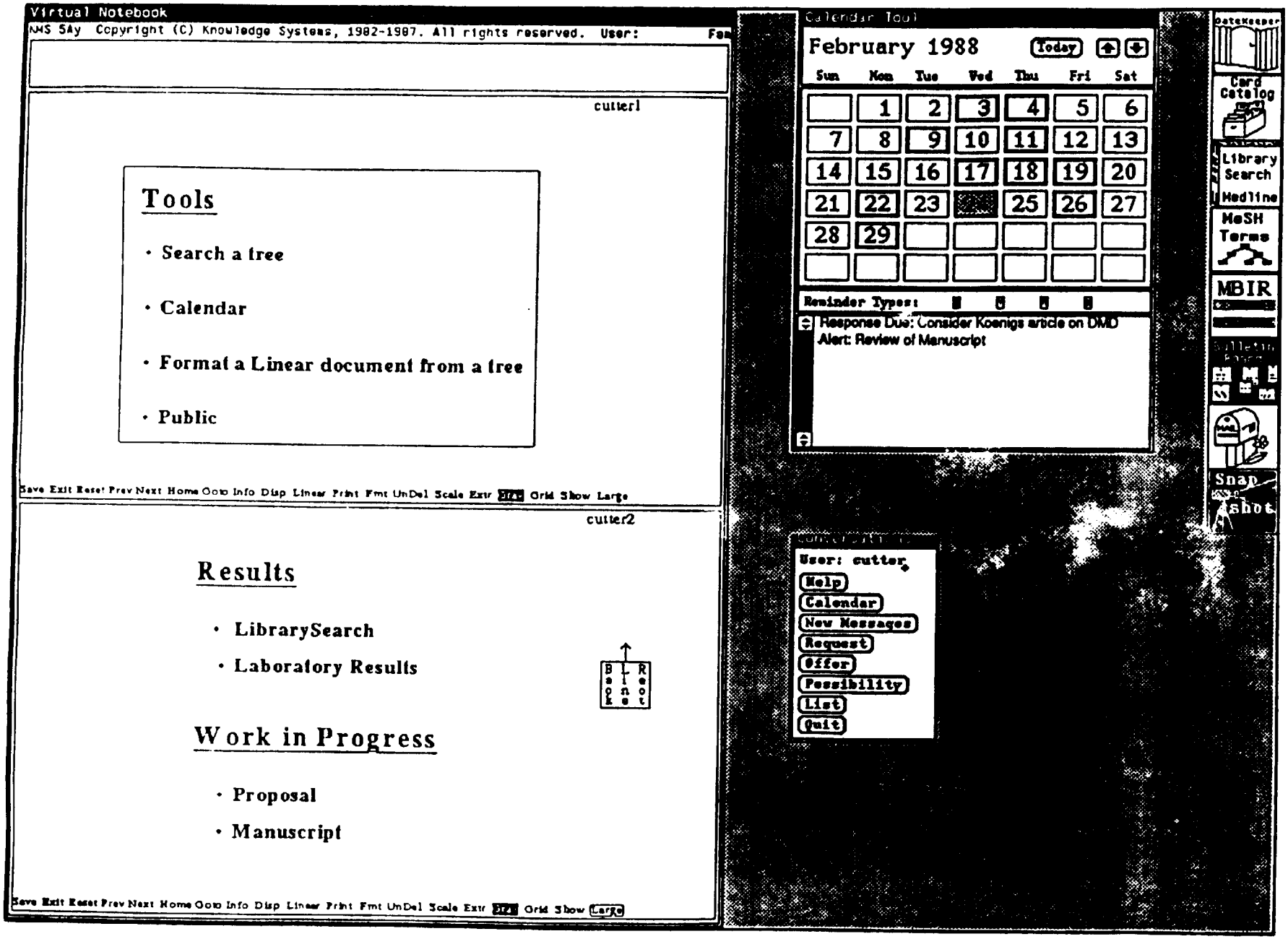
Virtual Notebook
NMS SAy Copyright (C) Knowledge Systems, 1982-1987. All rights reserved. User:
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• Format a Linear document from a tree
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Calendar Tool
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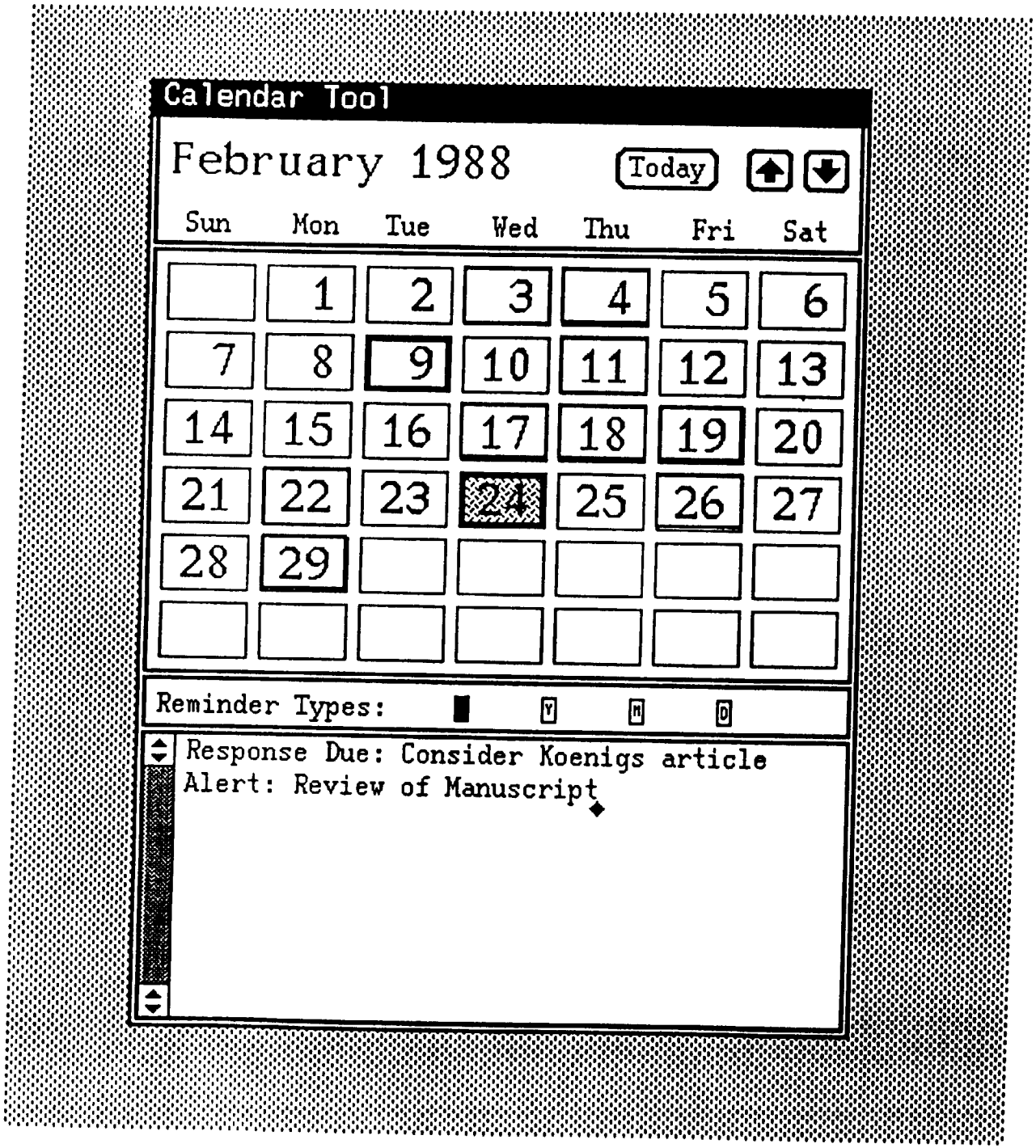
Calendar Tool
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Reminder Types:
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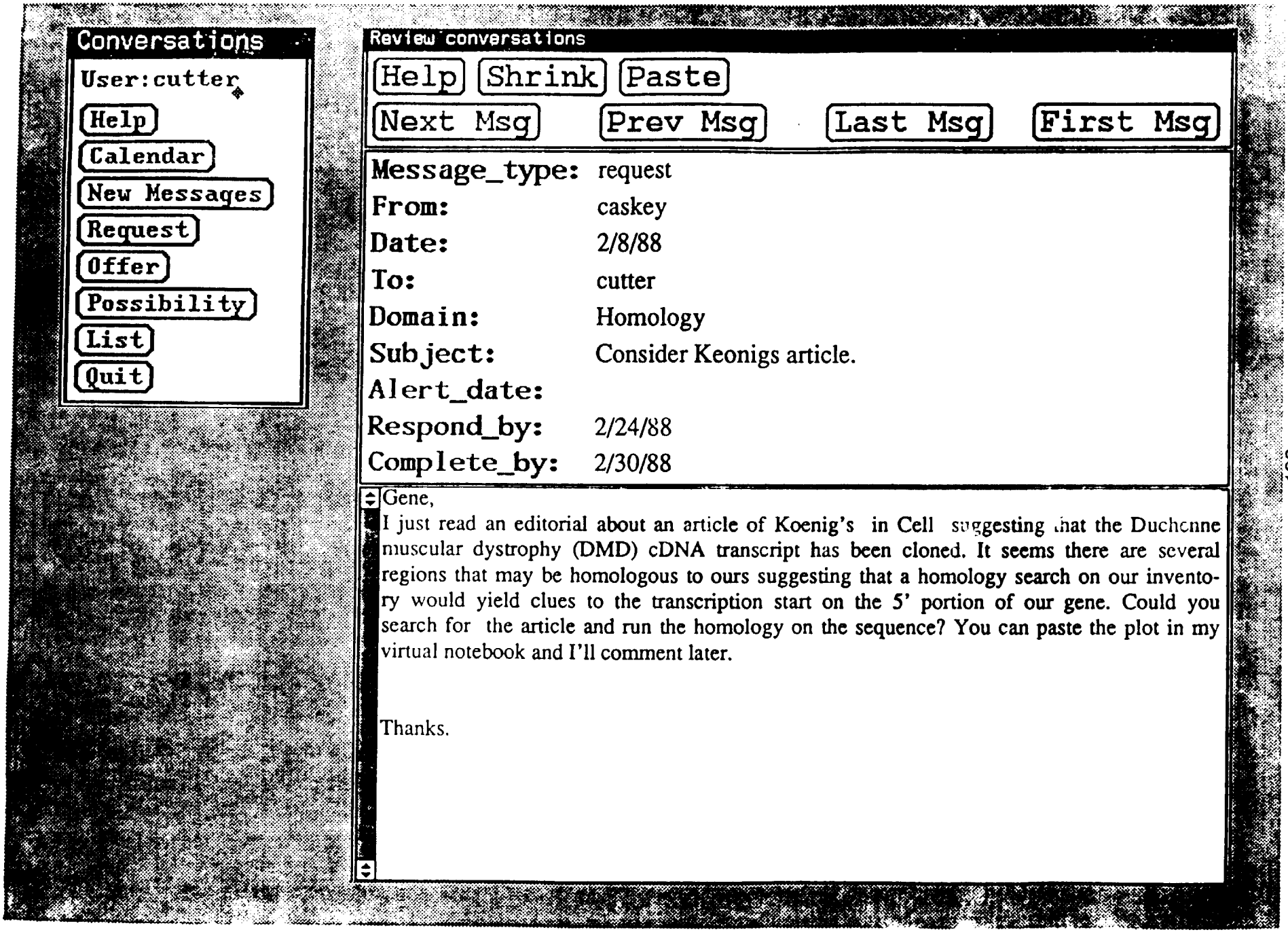
Andy [illegible]ger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From: caskey
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To: cutter
Domain: Homology
Subject: Consider Keonigs article.
Alert_date:
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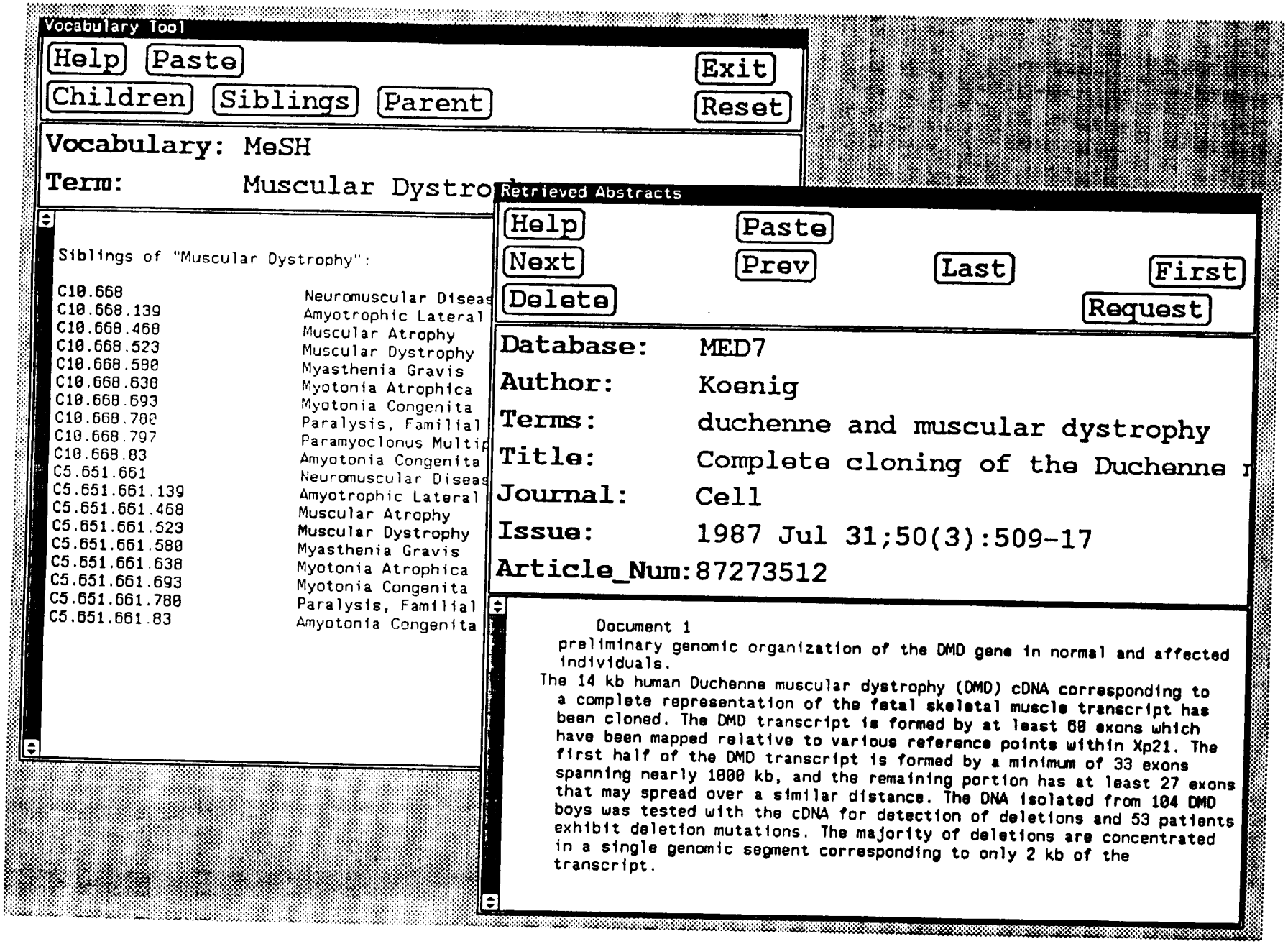
Complete_by: 2/30/88
Gene,
I just read an editorial about an article of Koenig's in Cell suggesting that the Duchenne muscular dystrophy (DMD) cDNA transcript has been cloned. It seems there are several regions that may be homologous to ours suggesting that a homology search on our inventory would yield clues to the transcription start on the 5' portion of our gene. Could you search for the article and run the homology on the sequence? You can paste the plot in my virtual notebook and I'll comment later.
Thanks.


Vocabulary Tool
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Siblings of "Muscular Dystrophy":
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C10.668.468 Muscular Atrophy
C10.668.523 Muscular Dystrophy
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C10.668.638 Myotonia Atrophica
C10.668.693 Myotonia Congenita
C10.668.780 Paralysis, Familial
C10.668.797 Paramyoclonus Multip
C10.668.83 Amyotonia Congenita
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Author: Koenig
Terms: duchenne and muscular dystrophy
Title: Complete cloning of the Duchenne
Journal: Cell
Issue: 1987 Jul 31;50(3):509-17
Article_Num: 87273512
Document 1
preliminary genomic organization of the DMD gene in normal and affected individuals.
The 14 kb human Duchenne muscular dystrophy (DMD) cDNA corresponding to a complete representation of the fetal skeletal muscle transcript has been cloned. The DMD transcript is formed by at least 60 exons which have been mapped relative to various reference points within Xp21. The first half of the DMD transcript is formed by a minimum of 33 exons spanning nearly 1000 kb, and the remaining portion has at least 27 exons that may spread over a similar distance. The DNA isolated from 104 DMD boys was tested with the cDNA for detection of deletions and 53 patients exhibit deletion mutations. The majority of deletions are concentrated in a single genomic segment corresponding to only 2 kb of the transcript.

shelltool - kms

KMS SAy Copyright (C) Knowledge Systems, 1982-1987. All rights reserved. User: burger Family: Times Face: Roman Size: 16 Spacing: 2 Thickness

cutter1

Tools

- Search a tree
- Calendar
- Format a Linear document from a tree
- Public

Symbols

Σ ©

∫ ∞

Home Frames

Caskey

Lawrence

Johnston

Brown

Save Exit Reset Prev Next Home Goto Info Disp Linear Print Fmt UnDel Scale Extr Grid Sho

Medline Articles

cutterlib1

National Library of Medicine Medline Articles

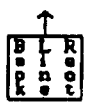
List of Stored Articles

search term: ion channels and sodium and xenopus

- Article1-physiology
- Article2-physiology
- Article3-physiology

search term: duchenne and muscular dystrohpy

- Article4-Koenig DMD cDNA



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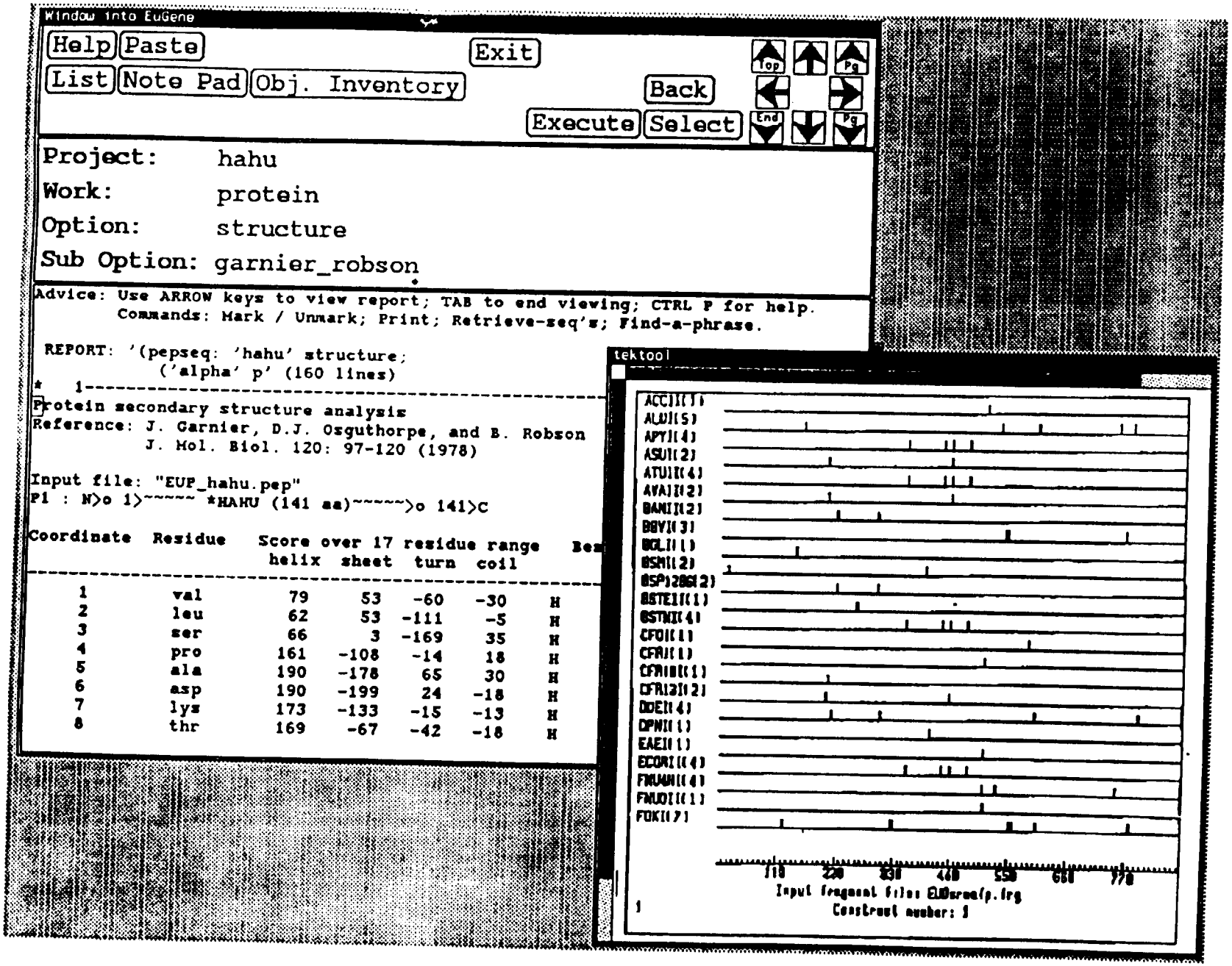
Window into EuGene
Help
Paste
Exit
List
Note Pad
Obj. Inventory
Back
Execute
Select
Project: hahu
Work: protein
Option: structure
Sub Option: garnier_robson
Advice: Use ARROW keys to view report; TAB to end viewing; CTRL P for help.
Commands: Mark / Unmark; Print; Retrieve-seq's; Find-a-phrase.
REPORT: '(pepseq: 'hahu' structure;
('alpha' p' (160 lines)
Protein secondary structure analysis
Reference: J. Garnier, D.J. Osguthorpe, and B. Robson
J. Mol. Biol. 120: 97-120 (1978)
Input file: "EUP_hahu.pep"
P1 : M>o 1>~~~~~ *HAHU (141 aa)~~~~~>o 141>C
Coordinate Residue Score over 17 residue range
helix sheet turn coil
1 val 79 53 -60 -30 H
2 leu 62 53 -111 -5 H
3 ser 66 3 -169 35 H
4 pro 161 -108 -14 18 H
5 ala 190 -178 65 30 H
6 asp 190 -199 24 -18 H
7 lys 173 -133 -15 -13 H
8 thr 169 -67 -42 -18 H
tektool
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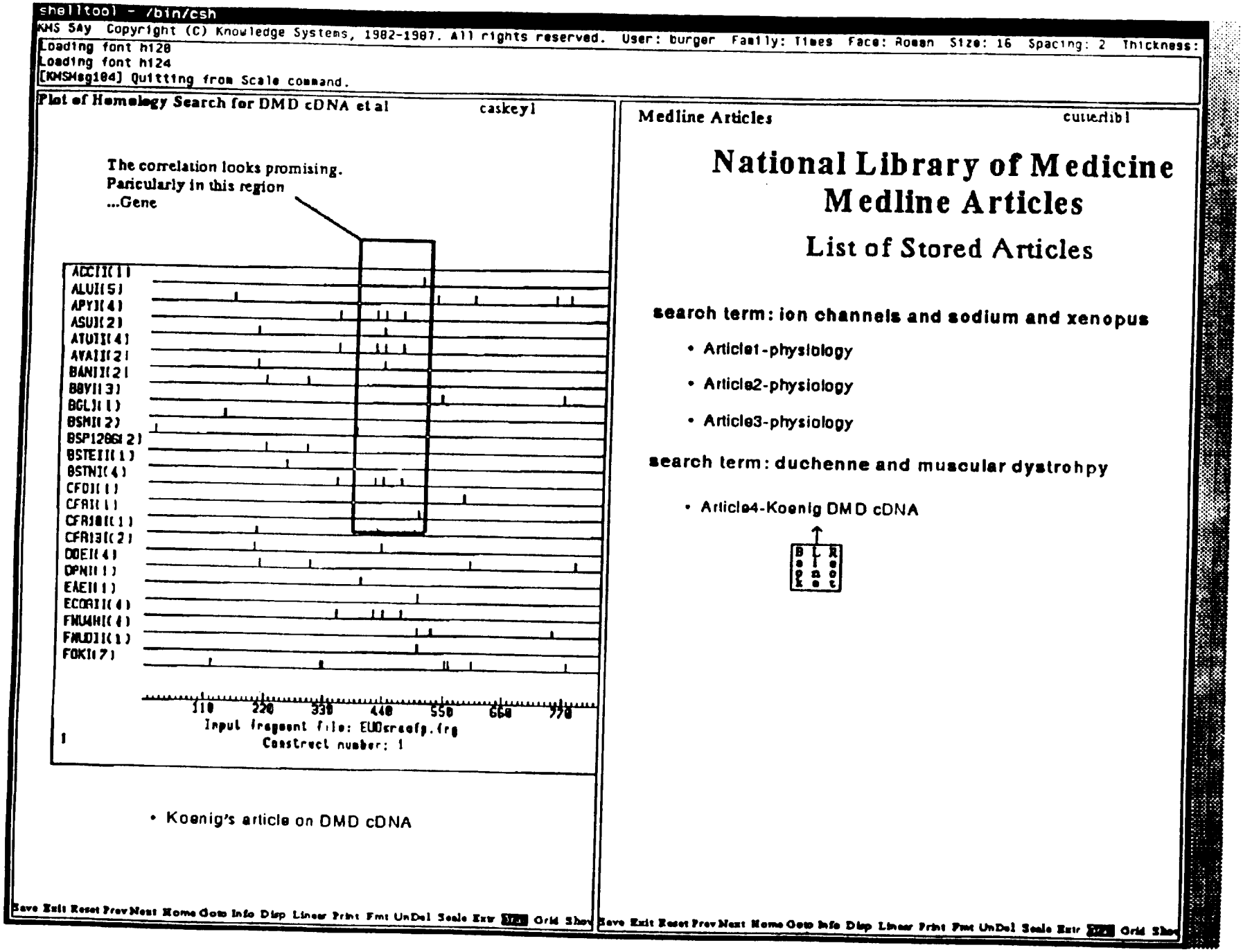
Construct number: 1


shelltool - /bin/csh
KMS SAy Copyright (C) Knowledge Systems, 1982-1987. All rights reserved. User: burger Family: Times Face: Roman Size: 16 Spacing: 2 Thickness:
Loading font h120
Loading font h124
[KMSMsg104] Quitting from Scale command.
Plot of Homology Search for DMD cDNA et al
caskey1
The correlation looks promising.
Paricularly in this region
...Gene
ACCII(1)
ALUI(5)
APYI(4)
ASUI(2)
ATUII(4)
AVAII(2)
BANI(2)
BBVI(3)
BGLI(1)
BSMI(2)
BSP120I(2)
BSTEII(1)
BSTNI(4)
CFOI(1)
CFRI(1)
CFR10I(1)
CFR13I(2)
DDEI(4)
DPNI(1)
EAEI(1)
ECORII(4)
FNU4HI(4)
FNUDII(1)
FOKI(7)
110
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330
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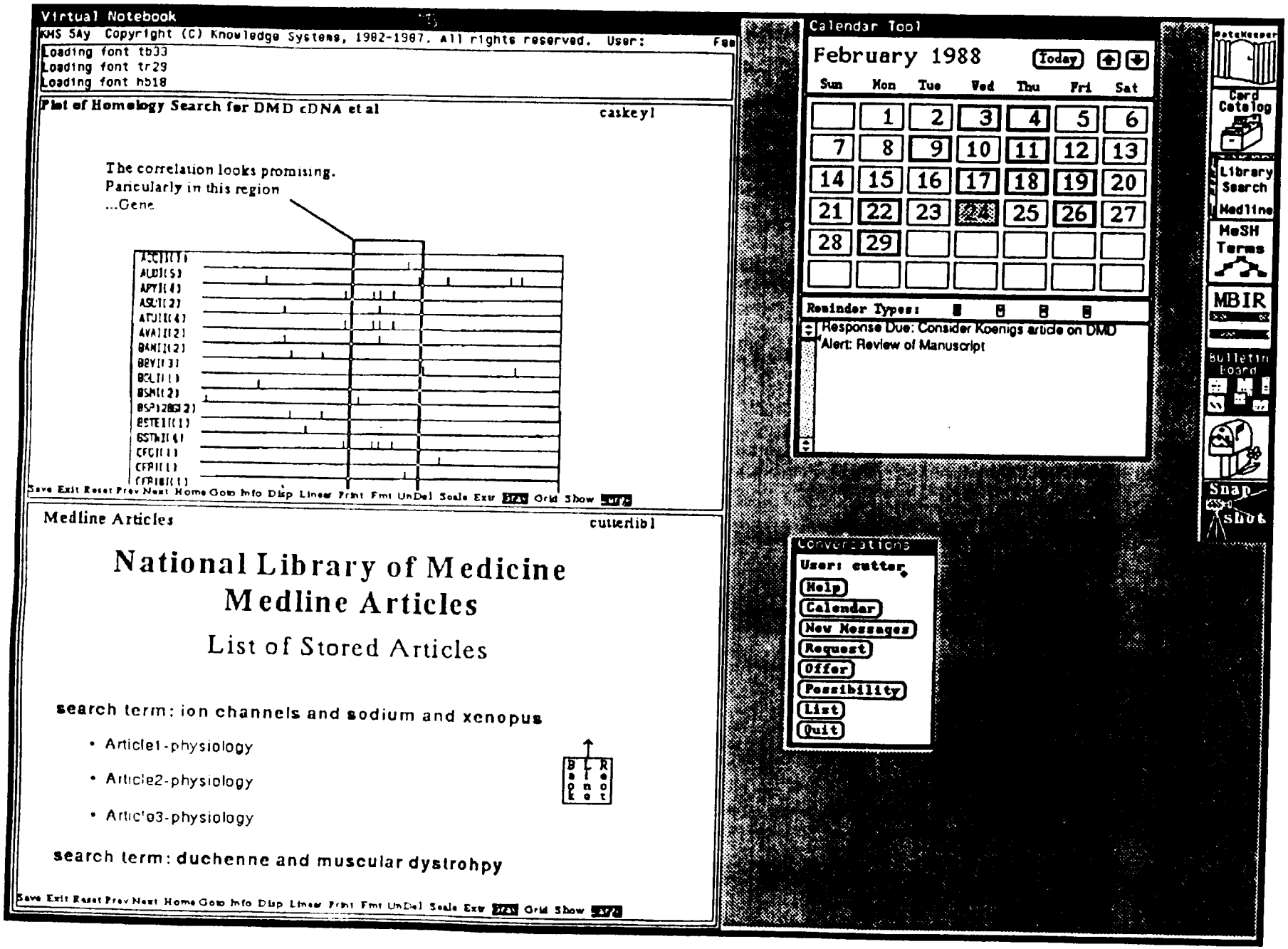
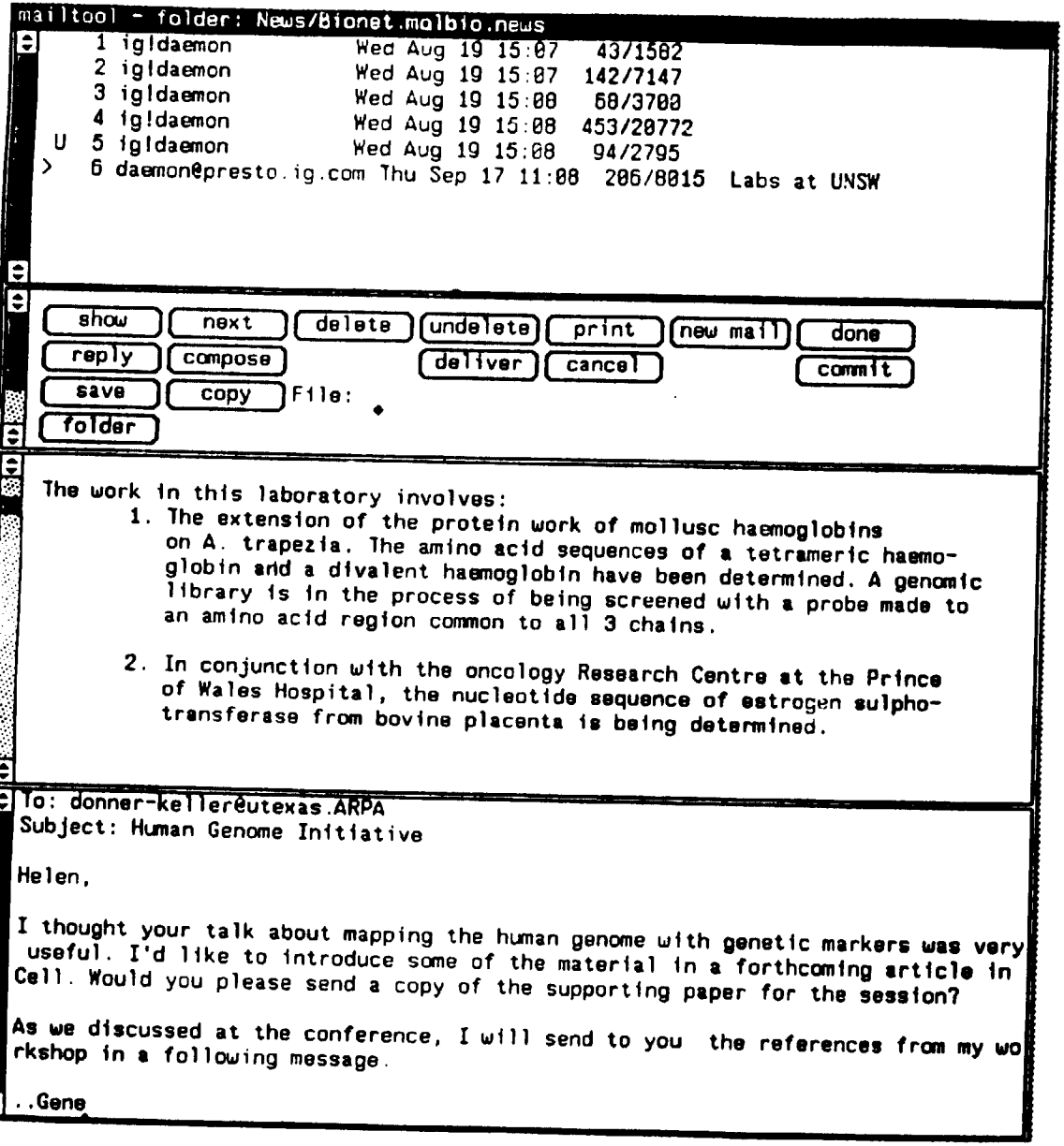
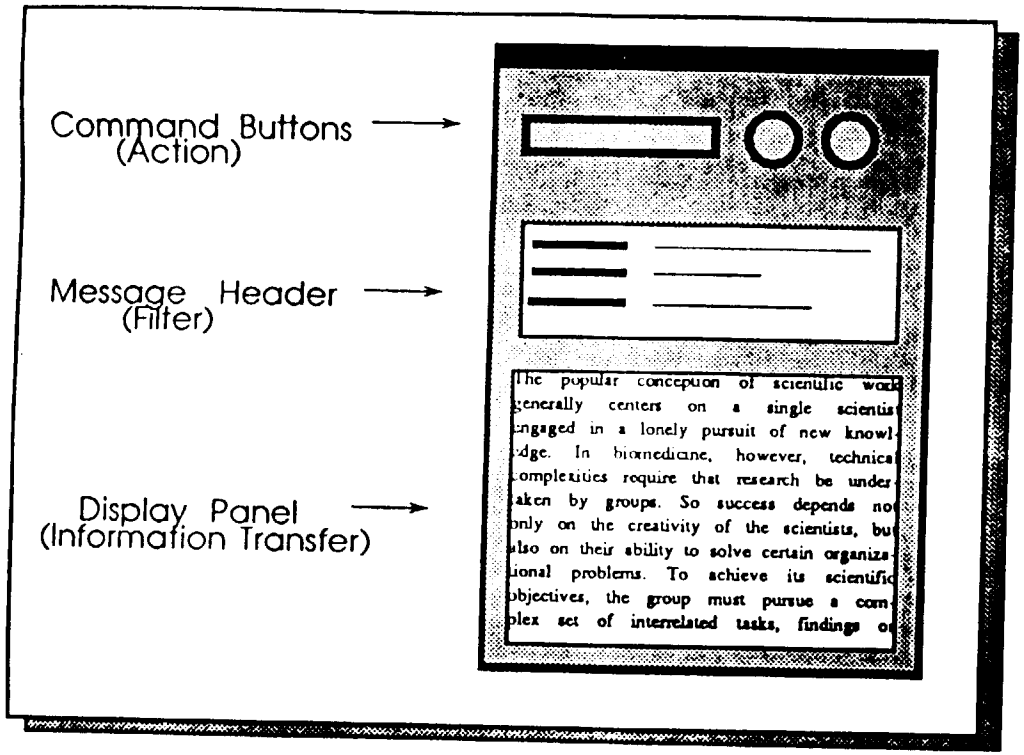
Input fragment file: ELNDcraofg.frg
Construct number: 1
1
• Koenig's article on DMD cDNA
Save Exit Reset Prev Next Home Goto Info Disp Linear Print Fmt UnDel Scale Exir Grid Shov
Medline Articles
cutterlib1
National Library of Medicine
Medline Articles
List of Stored Articles
search term: ion channels and sodium and xenopus
• Article1-physiology
• Article2-physiology
• Article3-physiology
search term: duchenne and muscular dystrohpy
• Article4-Koenig DMD cDNA
Save Exit Reset Prev Next Home Goto Info Disp Linear Print Fmt UnDel Scale Exir Grid Shov


Virtual Notebook
KMS SAy Copyright (C) Knowledge Systems, 1982-1987. All rights reserved. User:
Loading font tb33
Loading font tr29
Loading font hb18
Plot of Homology Search for DMD cDNA et al
caskey1
The correlation looks promising.
Particularly in this region
...Gene
Save Exit Reset Prev Next Home Goto Info Disp Linear Print Fmt UnDel Scale Exw Grid Show
Medline Articles
cutterlib1
National Library of Medicine
Medline Articles
List of Stored Articles
search term: ion channels and sodium and xenopus
• Article1-physiology
• Article2-physiology
• Article3-physiology
search term: duchenne and muscular dystrohpy
Calendar Tool
February 1988
Today
Sun Mon Tue Wed Thu Fri Sat
Reminder Types:
Response Due: Consider Koenigs article on DMD
Alert: Review of Manuscript
Conversations
User: cutter
Help
Calendar
New Messages
Request
Offer
Possibility
List
Quit
NoteKeeper
Card Catalog
Library Search
Medline
MeSH Terms
MBIR
Bulletin Board
Snapshot

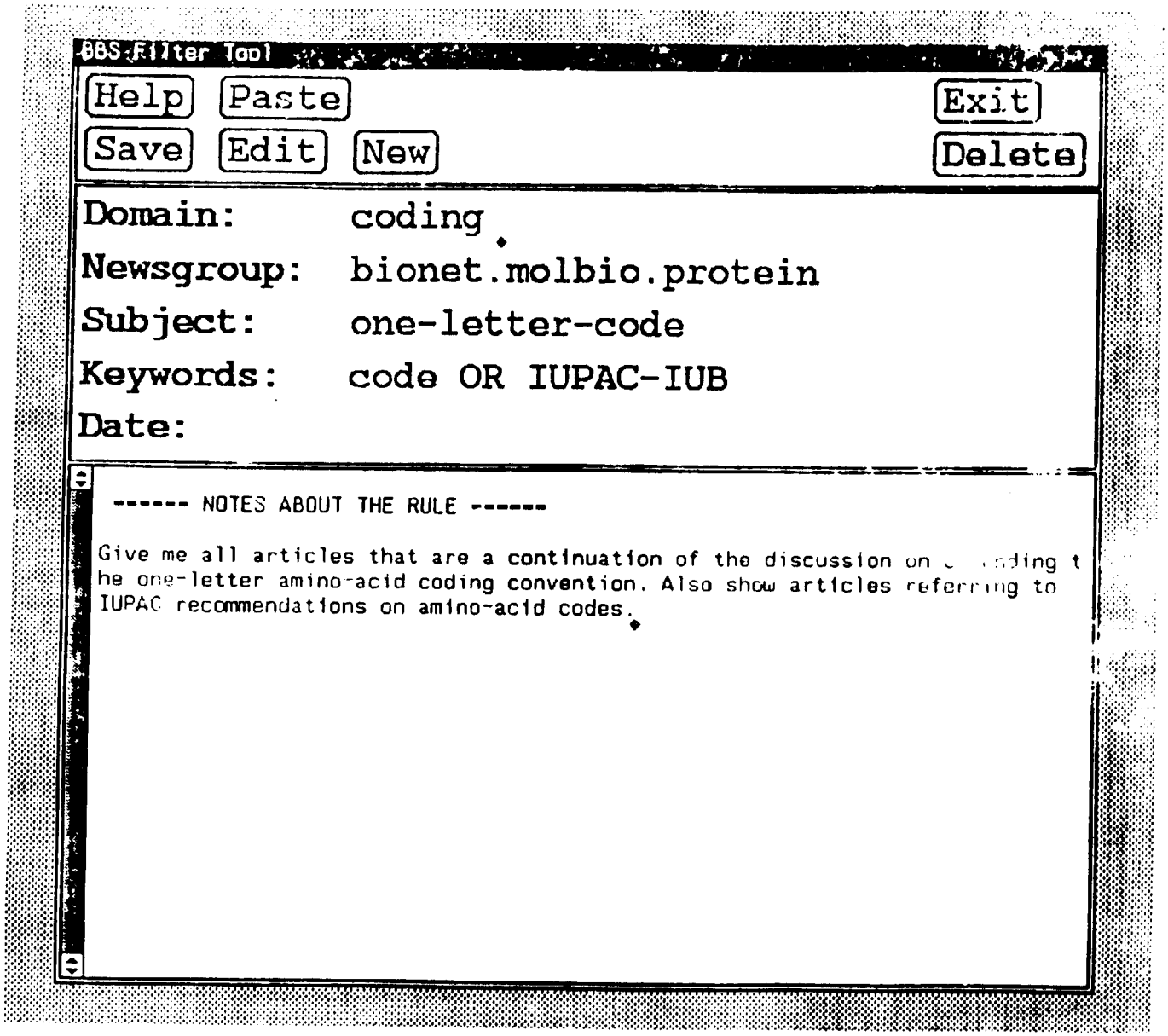

mailtool - folder: News/bionet.molbio.news
1 igldaemon Wed Aug 19 15:07 43/1582
2 igldaemon Wed Aug 19 15:07 142/7147
3 igldaemon Wed Aug 19 15:00 60/3700
4 igldaemon Wed Aug 19 15:08 453/20772
U 5 igldaemon Wed Aug 19 15:08 94/2795
> 6 daemon@presto.ig.com Thu Sep 17 11:08 206/8015 Labs at UNSW
show
next
delete
undelete
print
new mail
done
reply
compose
deliver
cancel
commit
save
copy
File:
folder
The work in this laboratory involves:
1. The extension of the protein work of mollusc haemoglobins on A. trapezia. The amino acid sequences of a tetrameric haemoglobin and a divalent haemoglobin have been determined. A genomic library is in the process of being screened with a probe made to an amino acid region common to all 3 chains.
2. In conjunction with the oncology Research Centre at the Prince of Wales Hospital, the nucleotide sequence of estrogen sulphotransferase from bovine placenta is being determined.
To: donner-keller@utexas.ARPA
Subject: Human Genome Initiative
Helen,
I thought your talk about mapping the human genome with genetic markers was very useful. I'd like to introduce some of the material in a forthcoming article in Cell. Would you please send a copy of the supporting paper for the session?
As we discussed at the conference, I will send to you the references from my workshop in a following message.
..Gene


Snap
shot
Snapshot Options
Frame =>
Paste Image
Paste Text
Capture Raster-file

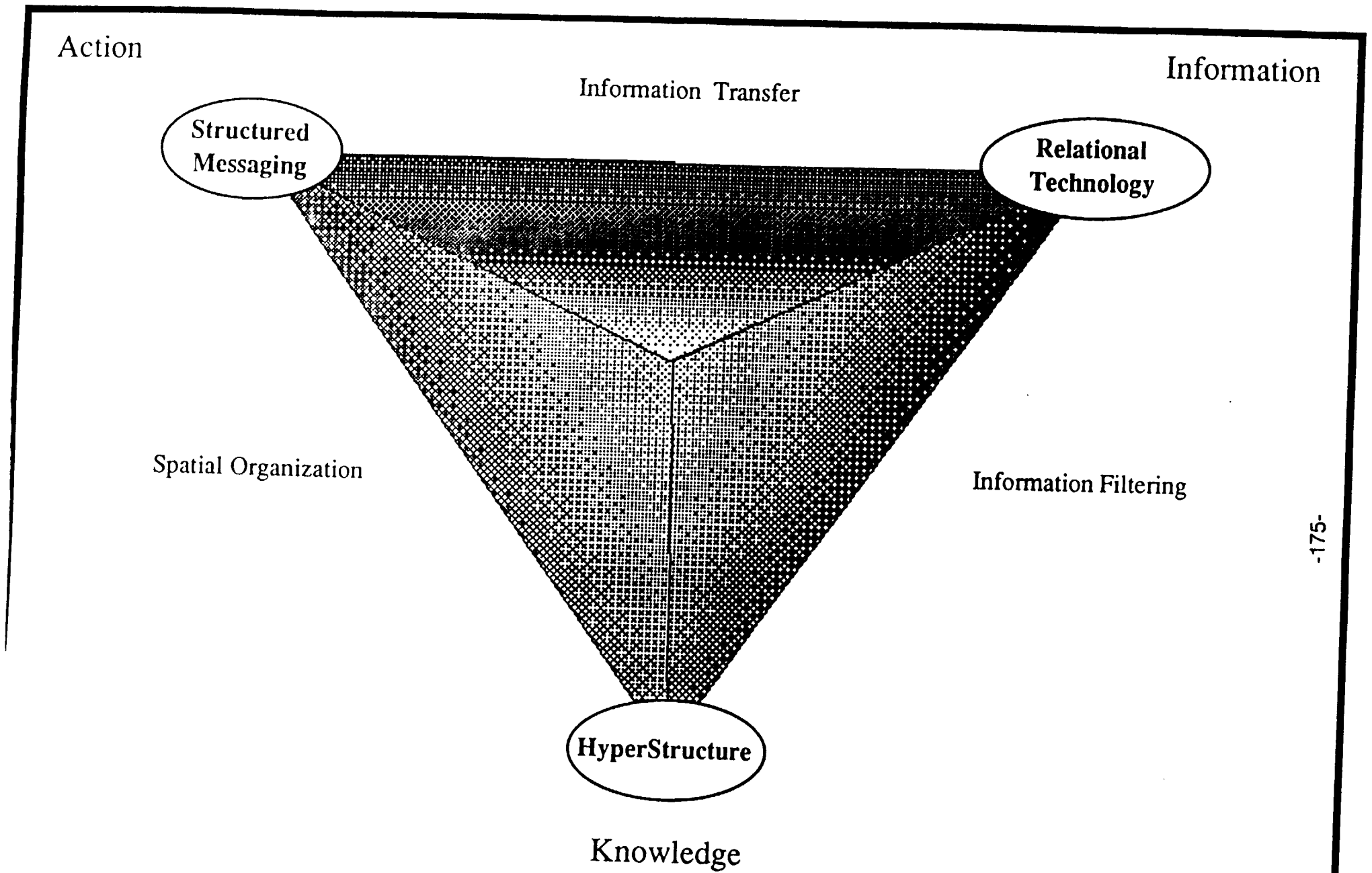


- Consistent Interface
- Information Filtering
- Group Specialization

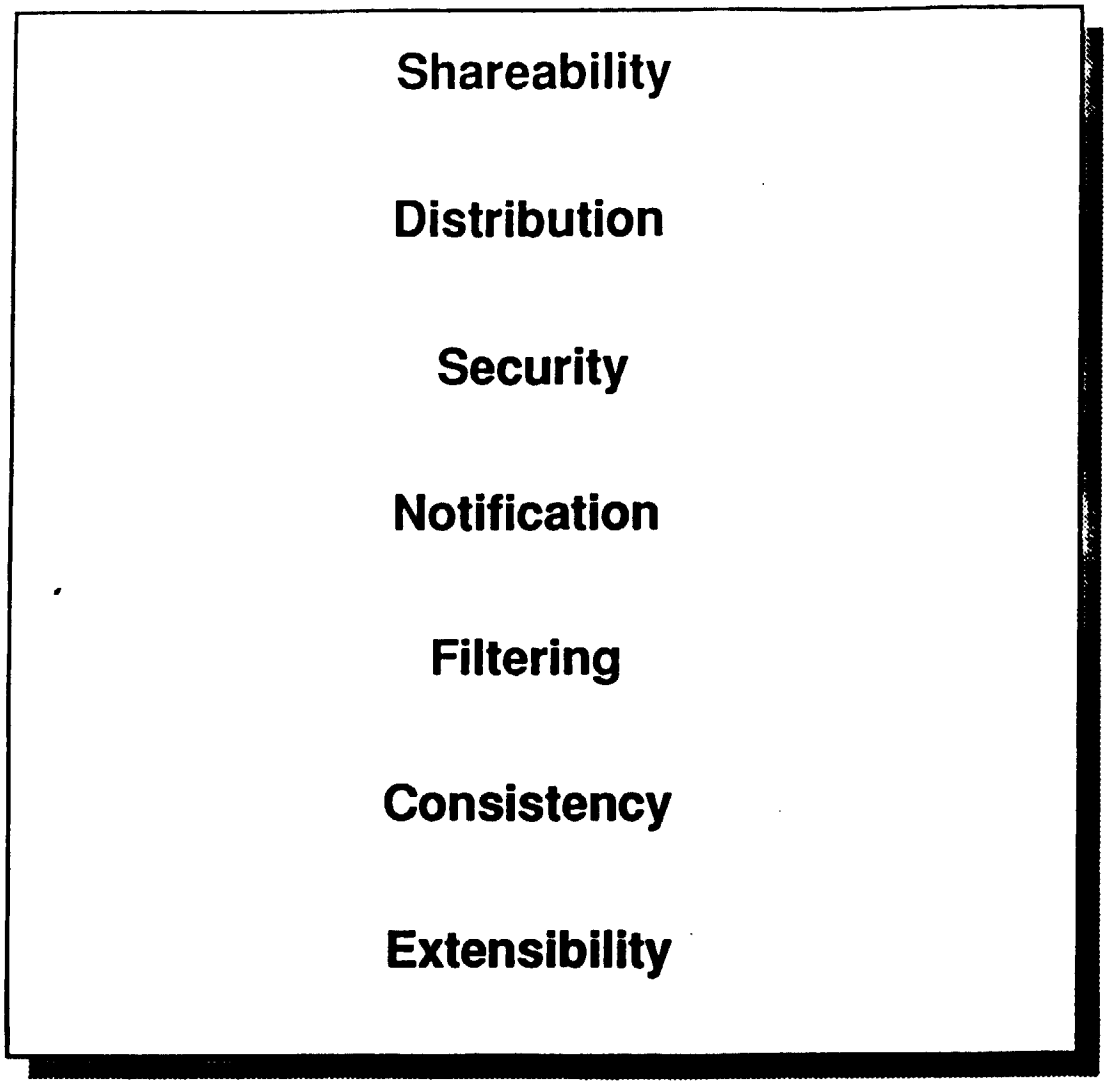
Structured Message Interface



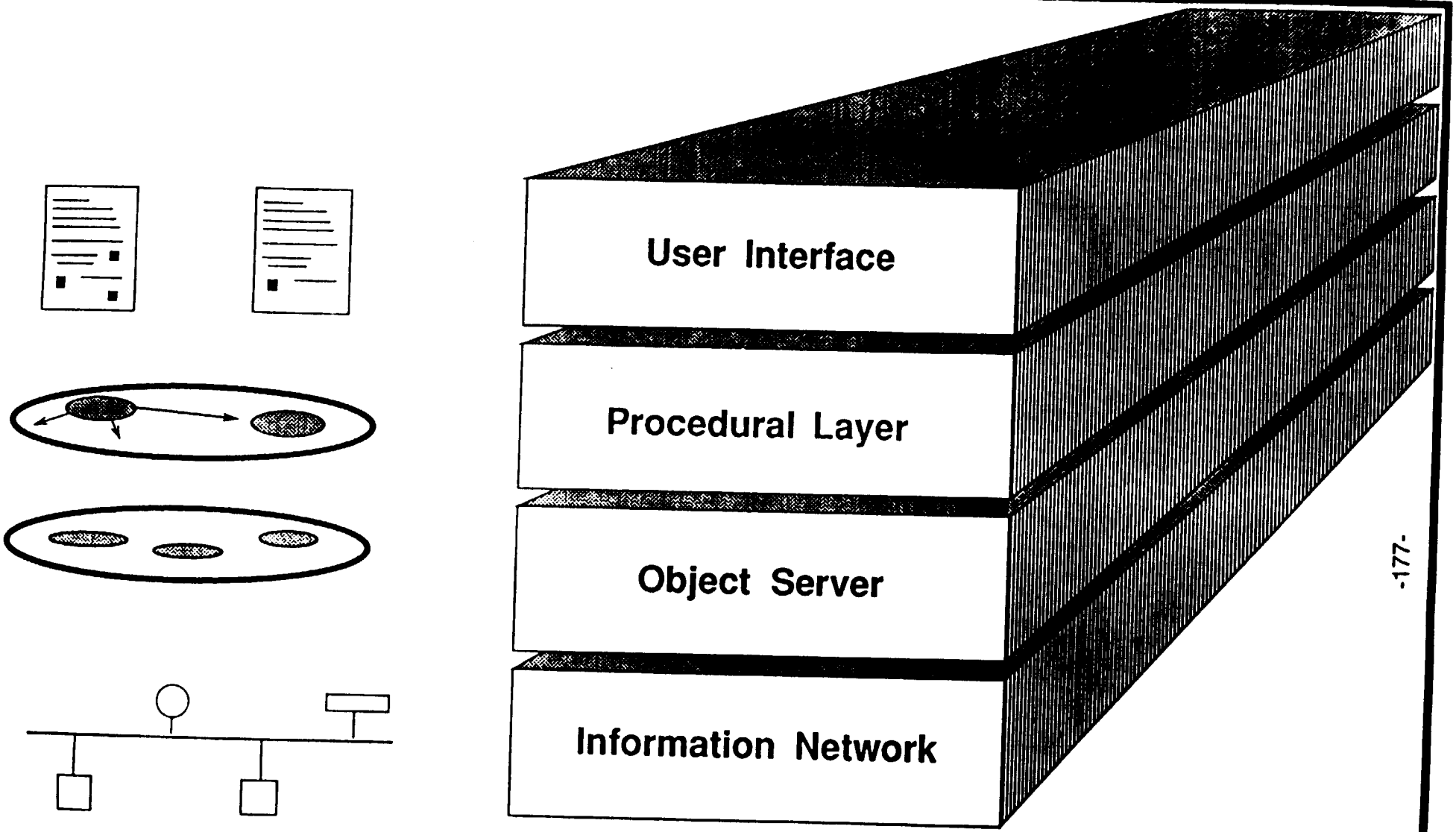
Filtering Electronic Bulletin Boards



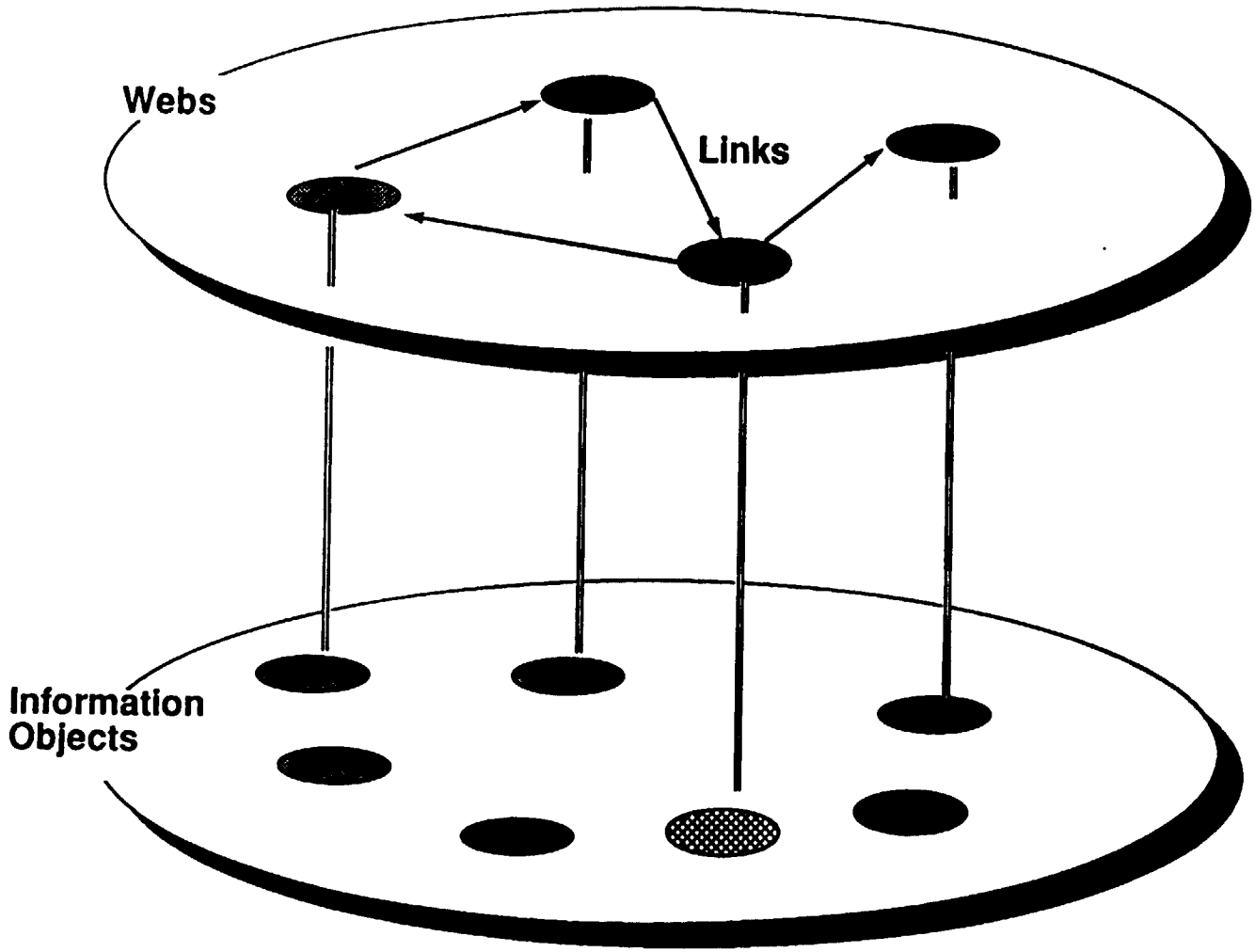
Information Management



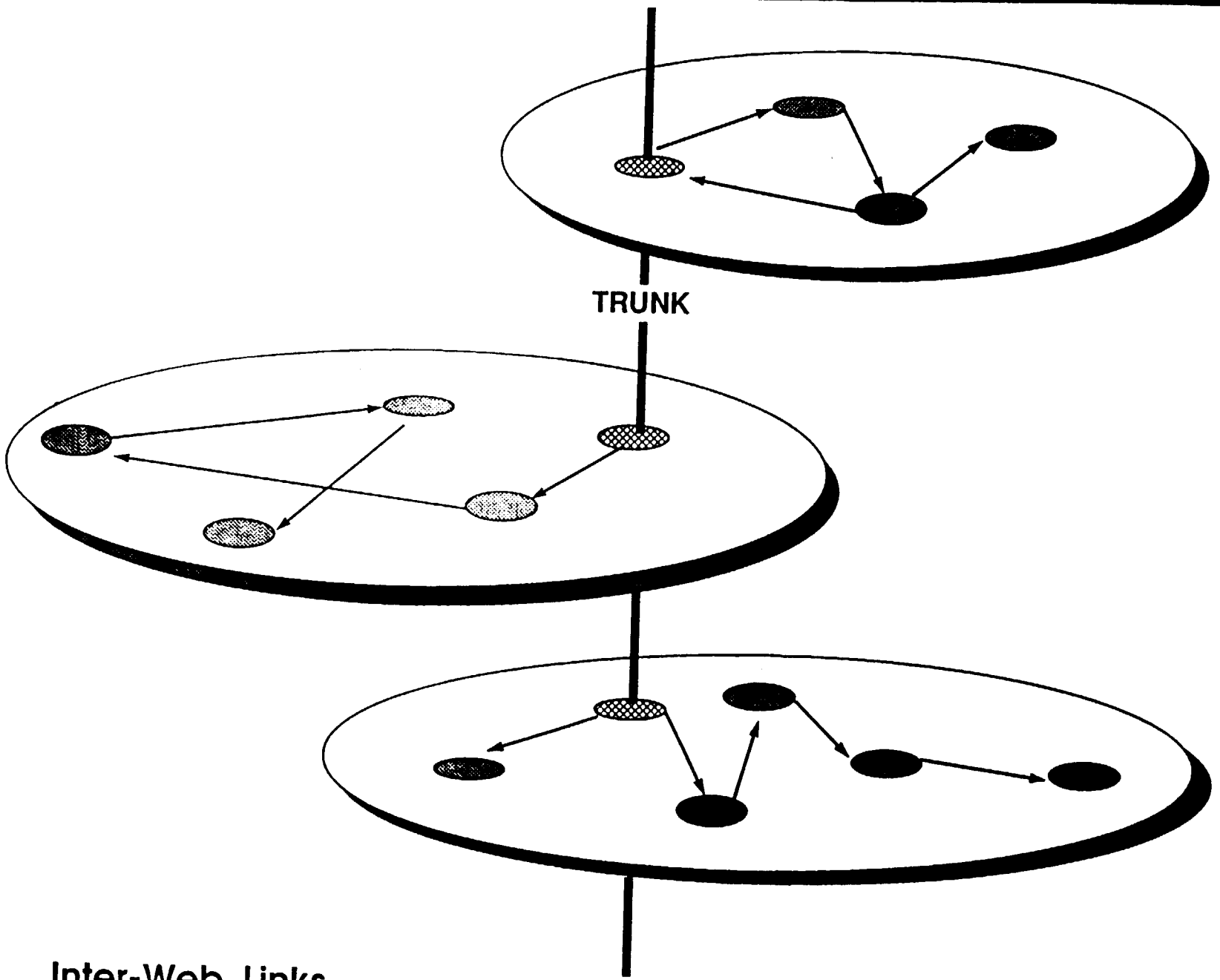
Group Issues in Hypermedia



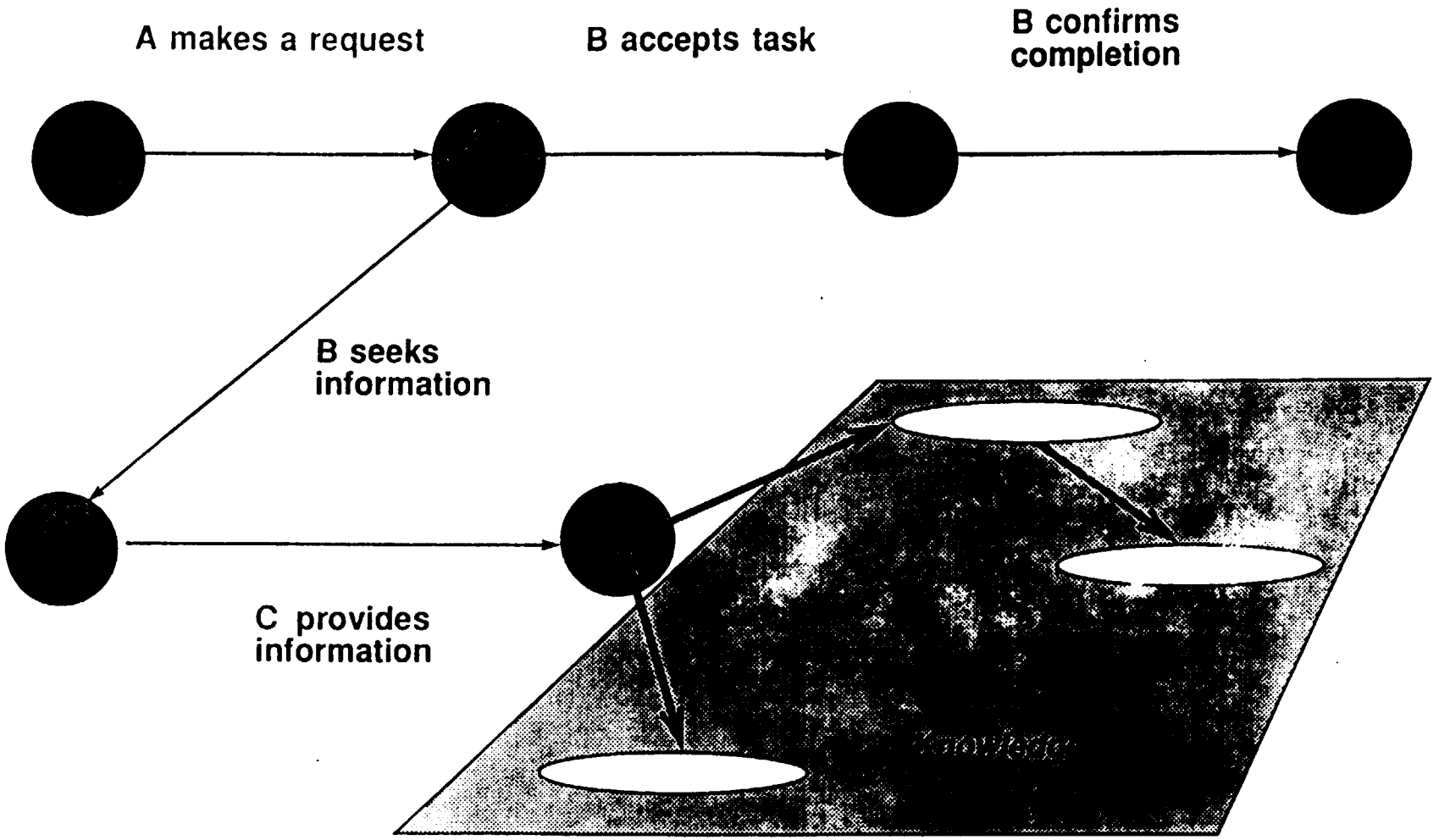
Virtual Notebook - Hyperstructure Architecture



Virtual Notebook Hyperstructure



Inter-Web Links



Spatial Mapping of Conversational and Informational Models

The Virtual Notebook:

Facilitates the establishment of links between information and knowledge bases

Coordinates tasks, the action of speciality in knowledge intensive groups

Incorporates hypermedia to facilitate cooperative work in the sharing of ideas

Summary

WALT SCACCHI

Maintaining Software Life Cycle Documents as Hypertext

Maintaining Software Life Cycle Documents as Hypertext

Walt Scacchi
Computer Science Dept.
University of Southern California
Los Angeles, CA 90089-0782
(213) 743-7424

August, 1988

Overview

- Introduction to the System Factory Approach
- Software Engineering Hypertext Environments
- Developing Configured Software Descriptions
- Managing Configured Software Descriptions
- Visualizing Configured Software Descriptions
- Reverse Software Engineering
- Conclusions

Introduction

The System Factory (SF) integrates:

- Software Engineering technologies
- Knowledge-based systems techniques
- Computer-aided manufacturing concepts
- Organizational analysis of computing work
- Packaging software technology for transfer and transition

Problems of LSSE

- Manage and train dynamic staff
- Construct computer-aided software engineering environments
- Support the evolution of multi-version software product families
- Specify reusable software components
- Support exploratory and rapid prototyping development techniques
- Integrate an open system of tools, techniques, management strategies, and staff skills

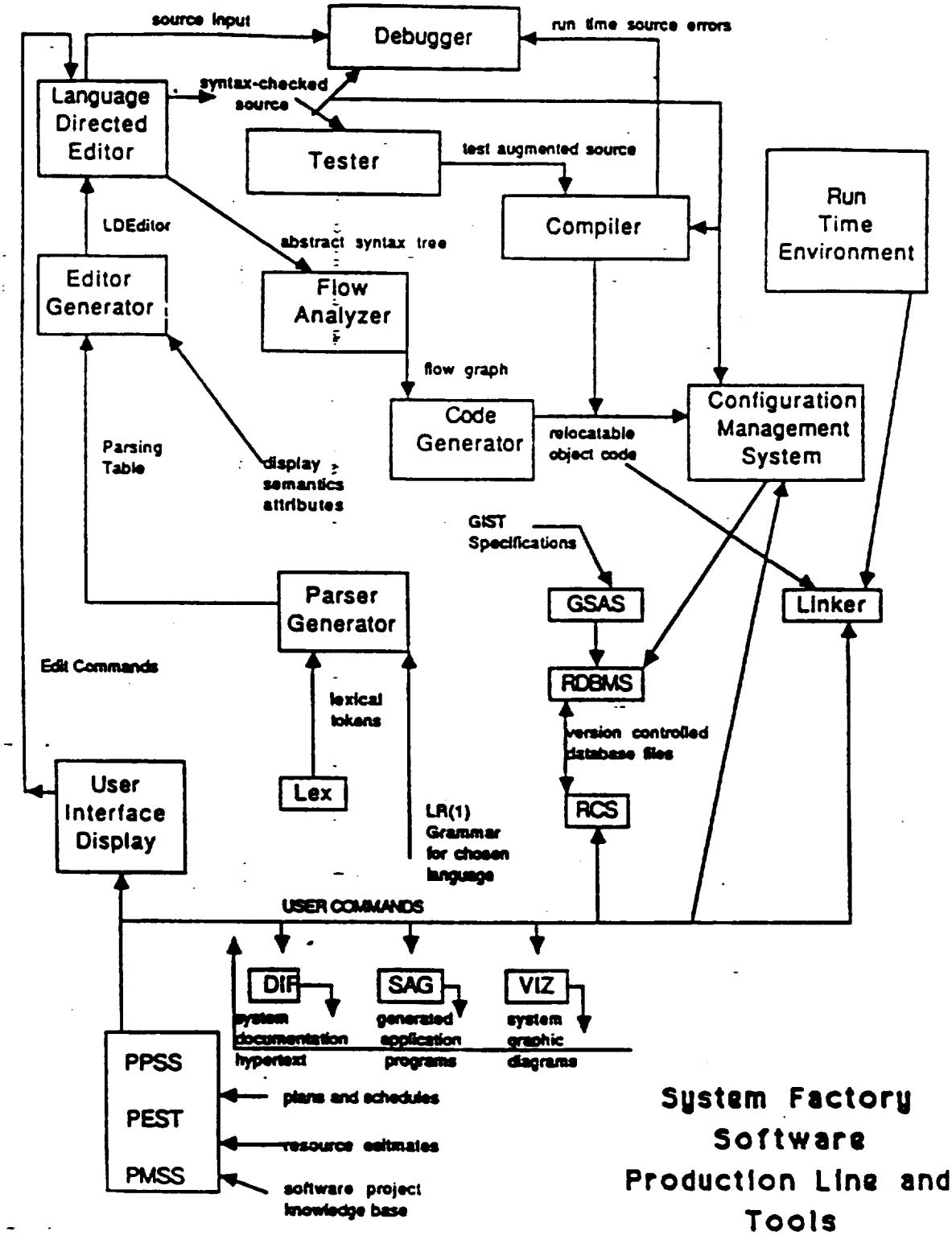
Introduction (con't)

The SF represents an innovative organizational approach to rapid, full-scale engineering of large software systems.

SF Products and Results

- SF CASEE tools
- SF System Life Cycle Engineering Techniques
- SF Project Management Strategies
- Iterative, Incremental, and Cyclic Methodology for LSSE

Figure 4-1: The System Factory SEE



A network or lattice of persistent text objects interconnected by typed edges ("relations")

Software Hypertext

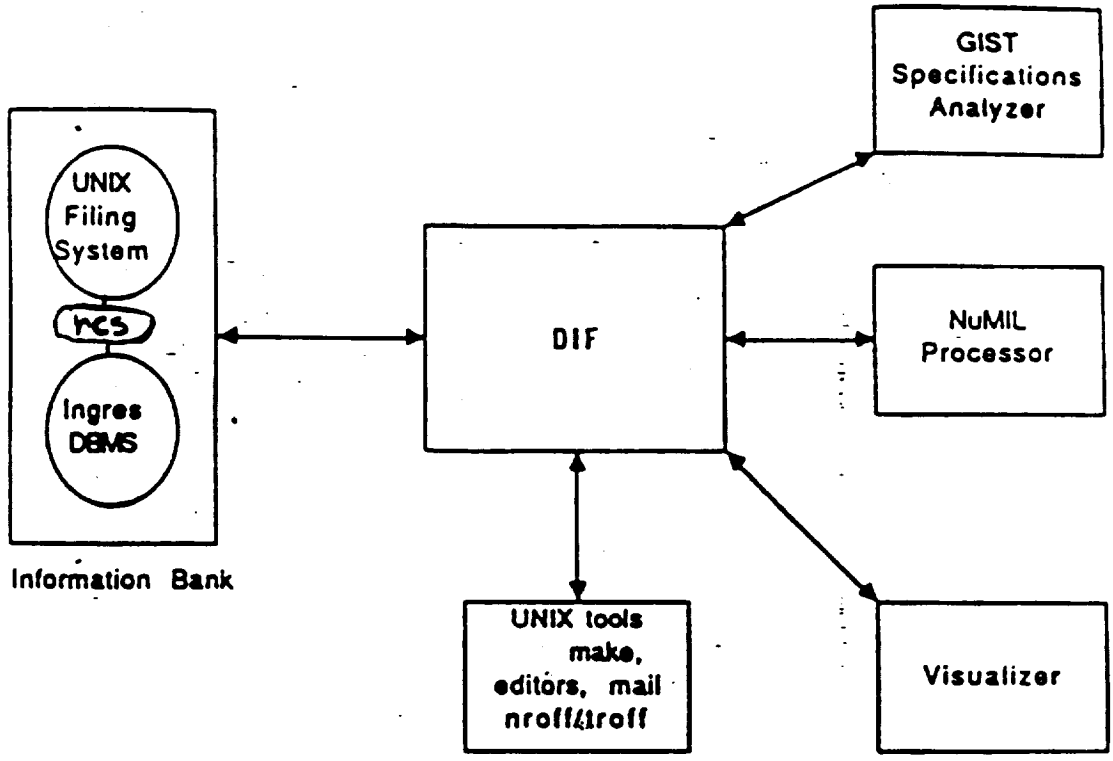
Hypertext with software objects (descriptions) and configuration management relations (links)

The Structure of Software Information

- *Links*: Semantic relations, may be operational
- *Basic Templates*: Semi-structured software object descriptions
- *Forms*: Cluster of related BTs
- *Configurations*: Threaded Form networks

Software Hypertext Environment

Ensemble of automated tools for developing, managing, and visualizing software hypertext


GIST
Specifications
Analyzer
UNIX
Filing
System
rcs
Ingres
DBMS
Information Bank
DIF
NuMIL
Processor
UNIX tools
make,
editors, mail
nroff/troff
Visualizer

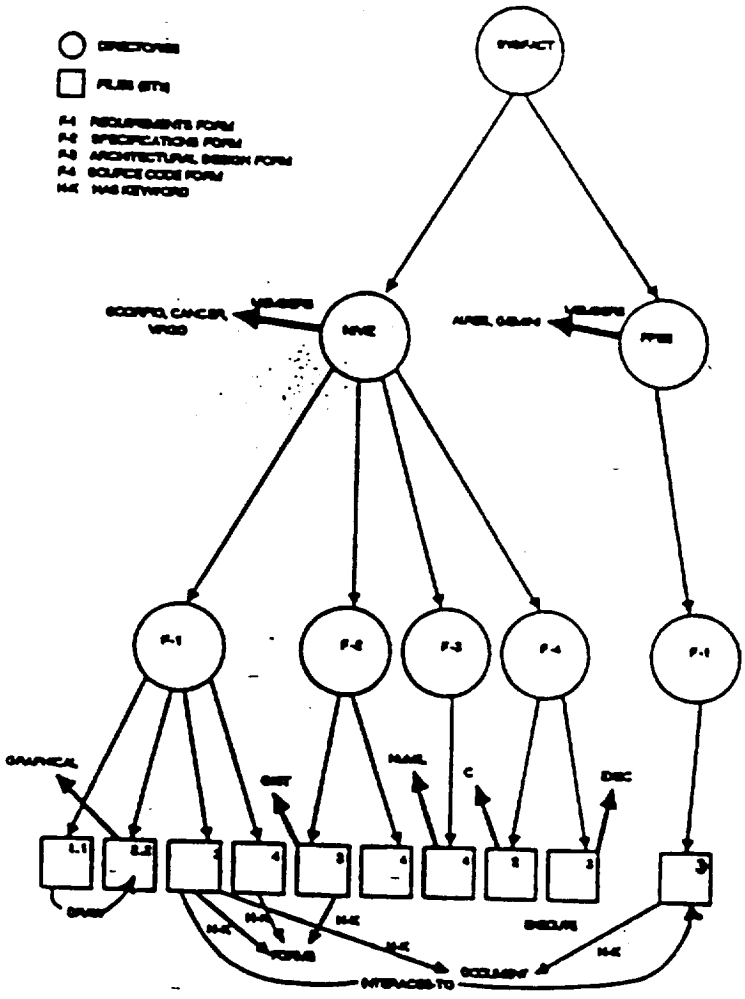
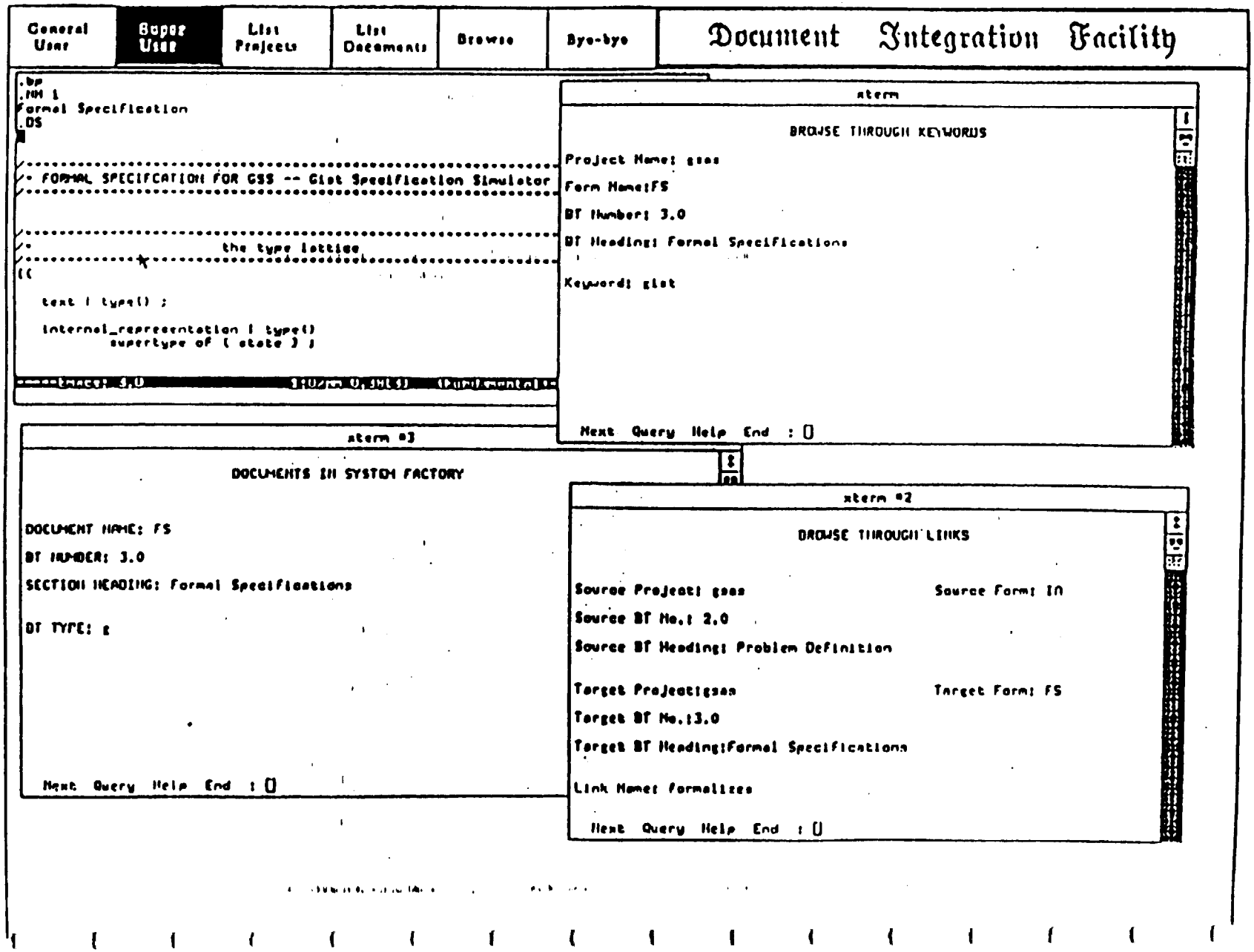


Figure 5: Hypertext of Software Documents


General User
Super User
List Projects
List Documents
Browse
Bye-bye
Document Integration Facility
.bp
.NH 1
Formal Specification
.DS
FORMAL SPECIFICATION FOR GSS -- Gist Specification Simulator
the type lattice
((
text (type()) ;
internal_representation (type()
supertype OF (state)) ;
xterm
BROWSE THROUGH KEYWORDS
Project Name: gss
Form Name:FS
DT Number: 3.0
DT Heading: Formal Specifications
Keyword: gist
Next Query Help End : 0
xterm #3
DOCUMENTS IN SYSTEM FACTORY
DOCUMENT NAME: FS
DT NUMBER: 3.0
SECTION HEADING: Formal Specifications
DT TYPE: g
Next Query Help End : 0
xterm #2
BROWSE THROUGH LINKS
Source Project: gss
Source Form: IN
Source DT No.: 2.0
Source DT Heading: Problem Definition
Target Project:gss
Target Form: FS
Target DT No.:3.0
Target DT Heading:Formal Specifications
Link Name: formalizes
Next Query Help End : 0

DIF: A Software Hypertext Environment

- Consistency and completeness analysis for formalized document nodes
- Intra- and Inter-document traceability
- Document formatting, display, and printing
- Indexed, query-driven, and geometrical browsing
- Template-based documentation standards
- Multi-version documents with/without sharable annotations
- Reusable software components catalog
- Online software inspections and walkthroughs
- Knowledge-based system and development process modeling

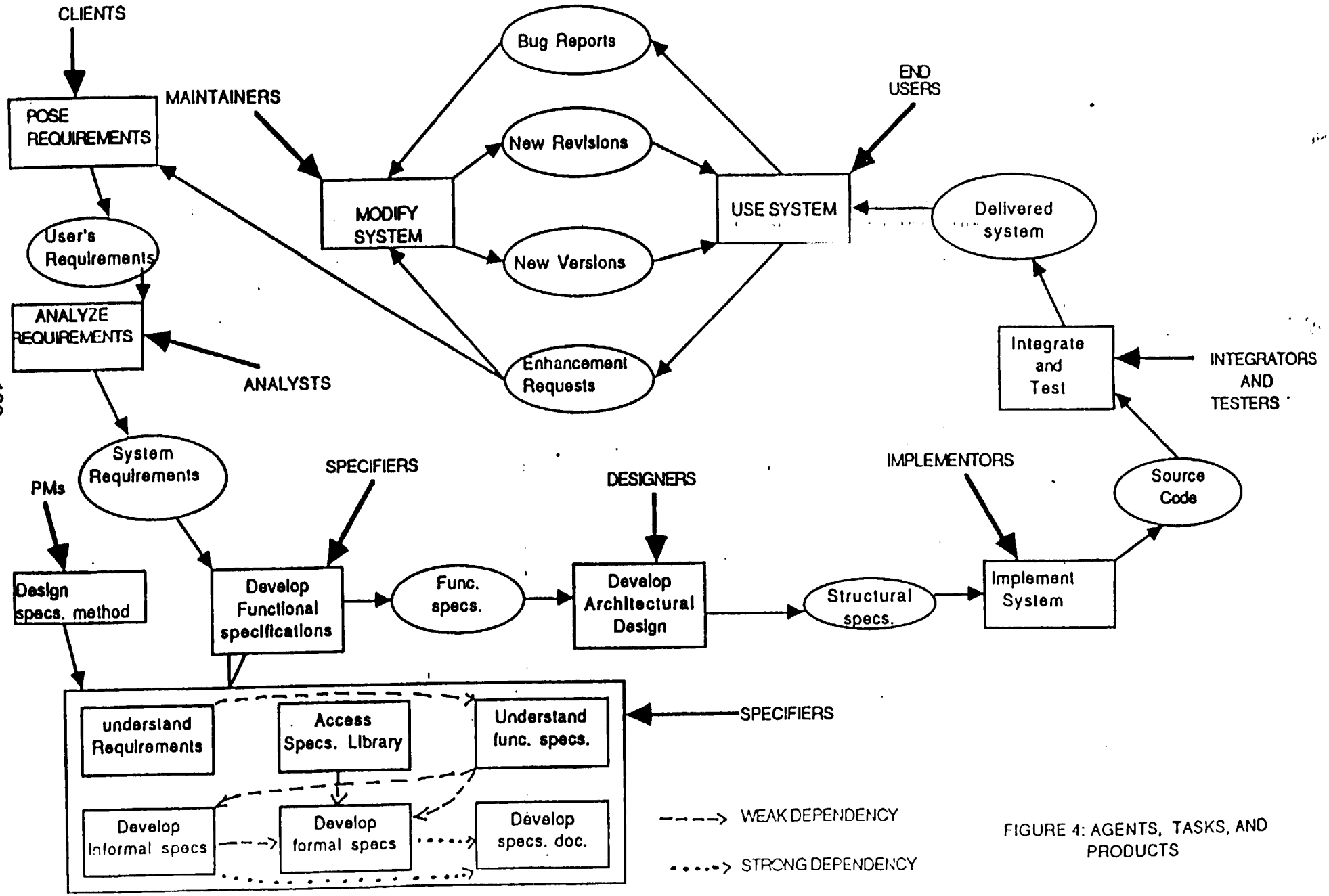
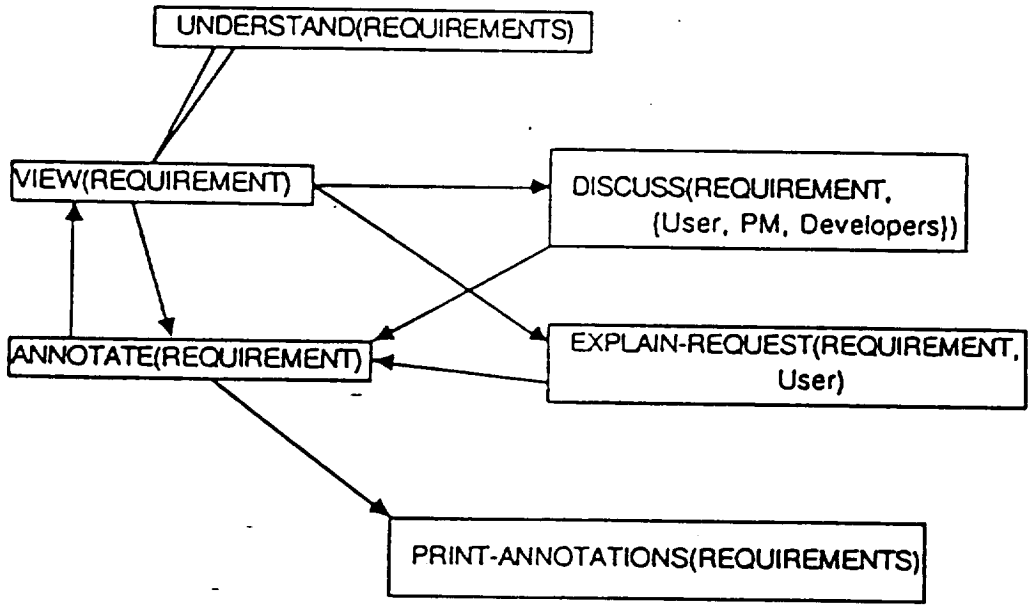


FIGURE 4: AGENTS, TASKS, AND PRODUCTS

identify the following primitive actions:

- VIEW(REQUIREMENT) — 'look at' an information object containing a User's requirement.
- ANNOTATE(REQUIREMENT) — attach notes of 'understanding' to an object X.
- EXPLAIN-REQUEST(REQUIREMENT, U) — request an explanation of a requirement from a User agent.
- DISCUSS(REQUIREMENT, $\{A_1, A_2, \ldots A_n\}$) — discuss a requirement with other agents of the process.
- PRINT-ANNOTATIONS(REQUIREMENTS) — organize and print the annotations attached to the requirements.

The action `Understand User's Requirements` can be understood in terms of these primitive actions as the following diagram shows:



Consider the diagram as a non-deterministic flowchart. The double lined arrows show the relation 'elaboration' [47] which means that the action ordering at the head of the arrow can be considered as the elaboration of the action at the tail of the arrow.

SF System Life Cycle Engineering Techniques

- Supporting the design and evolution of a software system's architectural configuration
- An SF tool suite supporting this activity
- A language for specifying families (versions) of module and subsystem interfaces and interconnections
- Support for managing, visualizing, and reverse engineering software architectural configurations

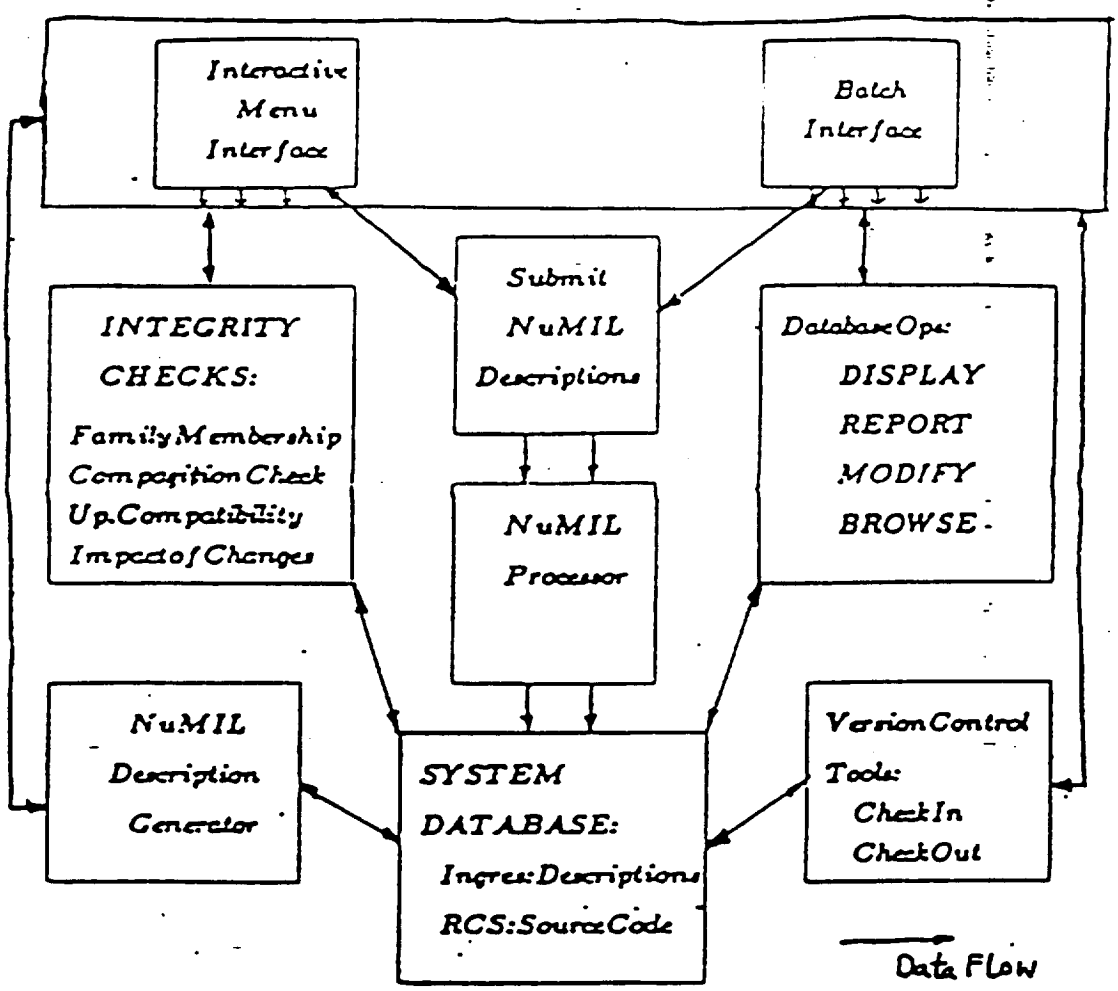


Figure 4-3: The SF Configuration Management System

Figure 1: Example of a NuMIL II specification

```
subsystem Sample is
   provide a, b, foo, x, baz;
   require c, d, z;

   compositions
      configuration {
         MSDOS3.3: composer          "scacchi (W. Scacchi)",
                   system            "pollux.usc.edu (128.125.1.16)",
                   revision date     "1/20/88 12:00";

         components
            M_1 -> version_1, M_2 -> version_2, M_3 -> default;
      }

      configuration {
         BSD4.2: composer          "swamy (K. Swamy)",
                 system            "c.isi.edu (26.3.0.103)",
                 revistion date    "1/15/88 11:15";

         components
            M_2 -> version_1, M_1 -> version_2, M_3 -> default;
      }

      configuration {
         VMS4.6: composer          "swamy (K. Swamy)",
                 system            "c.isi.edu (26.3.0.103)",
                 revistion date    "3/15/1988 14:40:53 PST";

         components
            M_2 -> version_1, M_1 -> version_1, M_3 -> default;
      }

end
```

Figure 1: Example of a NuMIL II specification (cont'd)

```
module M_1 is
   provide a, foo;
   require d, b;
   implementations
      version {
         version_1: realization   /u/joec/x.c,
                    owner         "joec (Joe S. Chen)",
                    system        "sdcrdcf!oberon!serl (uucp)",
                    revision date "01/19/88 22:36:43 PST";

         provide resources
            int a;
            short foo;

            end resources

         require resources
            int b, d;

            end resources

      } /* version_1 */

      version {
         version_2: realization   "/w/lam/y.c",
                    owner         "lam (Curtz S. Lam)",
                    system        "pollux.usc.edu (128.125.1.16)",
                    revision date "12/11/87 14:00:00 PST";

         provide resources
            float a;
            int foo;

            end resources

         require resources
            $ b, d $

            end resources

      } /* version_2 */
end
```

Figure 2: General information about objects

Relation: *ALLOBJS*

Object		*Creation*		*Modification*	
Name	*Type*	*Date*	*Time*	*Date*	*Time*
S	sub	02/09/1986	03:23:00 PST	01/20/1988	12:00:00 PST
M_1	mod	02/05/1986	16:40:00 PST	01/19/1988	22:36:43 PST
M_2	mod	02/10/1986	11:40:00 PST	01/09/1988	09:30:00 PST
M_3	mod	11/10/1987	10:05:28 PST	05/10/1988	15:33:26 PST

Relation: *OBJECT_PROVIDE*

Object Name	*Resource Name*
S	a
S	b
M_1	a
M_1	foo
M_2	b
M_3	x
M_3	baz

Relation: *OBJECT_REQUIRE*

Object Name	*Resource Name*
S	c
S	d
M_1	b
M_1	d
M_2	c
M_2	foo
M_3	z

Figure 3: Realizations of configurations and module versions

Relation: *SUBSYS_CONFIG*

Subsys. Name	*Config. Name*	*Composer's UserID*	*Access*	*Revision*	
				Date	*Time*
S	MSDOS3.3	1 (scacchi)	r w r – r –	01/20/1988	12:00:00 PST
S	BSD4.2	2 (swamy)	r w r – r –	01/15/1988	11:15:00 PST
S	VMS4.6	2 (swamy)	r w r – r –	03/15/1988	14:40:53 PST

Relation: *COMPONENTS*

Subsystem Name	*Configuration Name*	*Component Name*	*Selector Value*
S	MSDOS3.3	M_1	version_1
S	MSDOS3.3	M_2	version_2
S	MSDOS3.3	M_3	default
S	BSD4.2	M_1	version_2
S	BSD4.2	M_2	version_1
S	BSD4.2	M_3	default
S	VMS4.6	M_2	version_1
S	VMS4.6	M_1	version_1
S	VMS4.6	M_3	default

Relation: *MODULE_VERSION*

Module Name	*Version Name*	*Lang.*	*Owner's UserID*	*Access*	*Revision*		*FileSpec.*
					Date	*Time*	
M_1	version_1	C	3	r w r w r –	01/19/1988	22:36:43 PST	/u/joec/x.c
M_1	version_2	C	5	r w r – r –	12/11/1987	14:00:00 PST	/w/lam/y.c
M_2	version_1	C	2	r w r – r –	01/09/1988	09:30:00 PST	/sf/m.c
M_2	version_2	C	4	r w r w r –	01/05/1988	23:30:00 PST	n.c
M_3	default	Fortran	5	r w r – r –	05/10/1988	15:33:26 PST	/w/lam/m.f

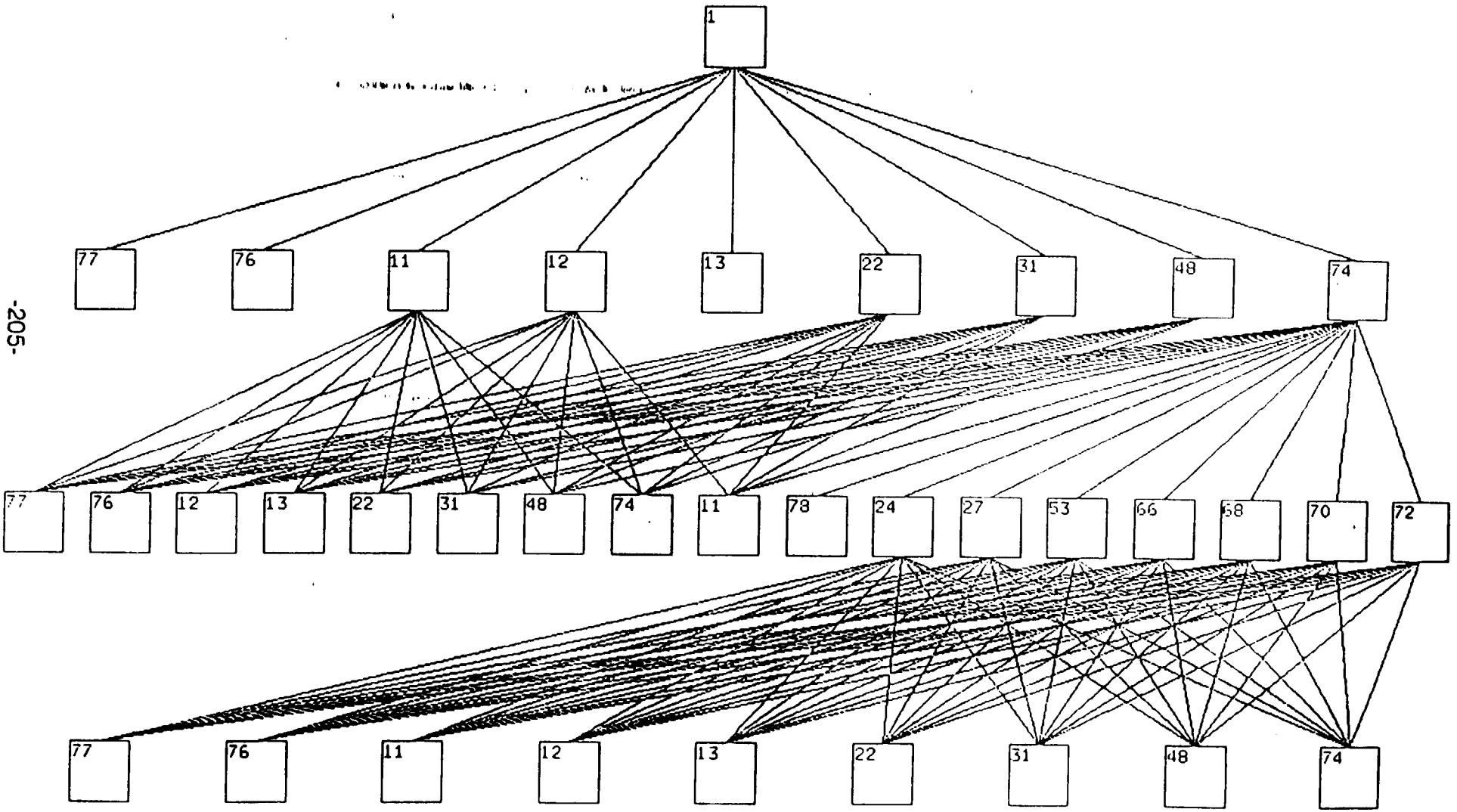
Visualizing Software Configurations

Requires NuMIL description of software architecture:

- *Constructed* as architectural design
- *Generated* from source code (i.e., structural design extraction)
- *Retrieved* from configuration hypertext management system

But there are other problems as well!

Examples follow.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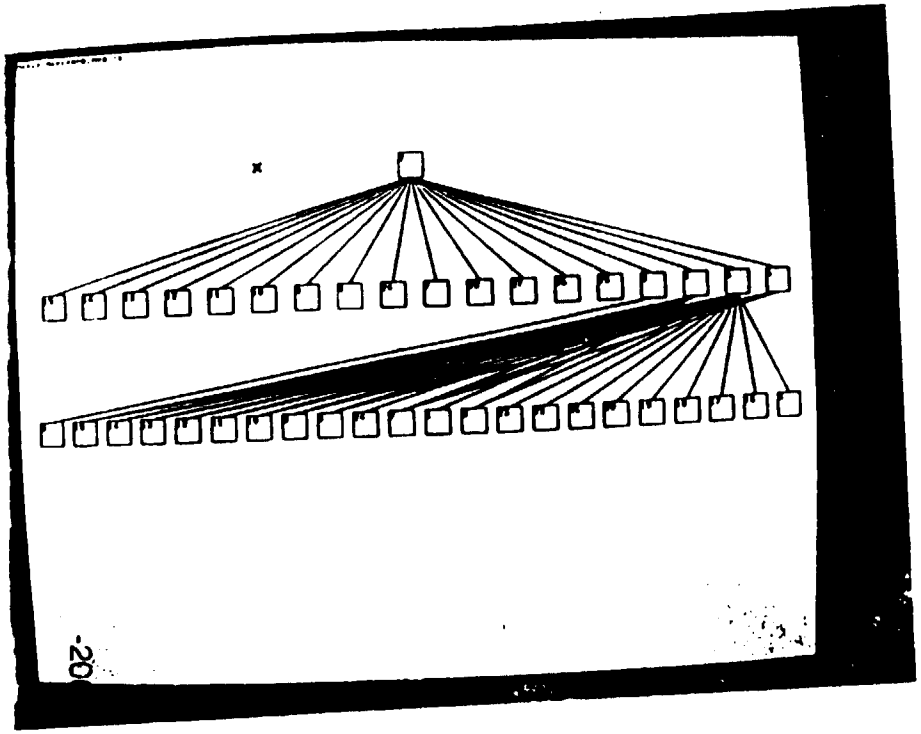
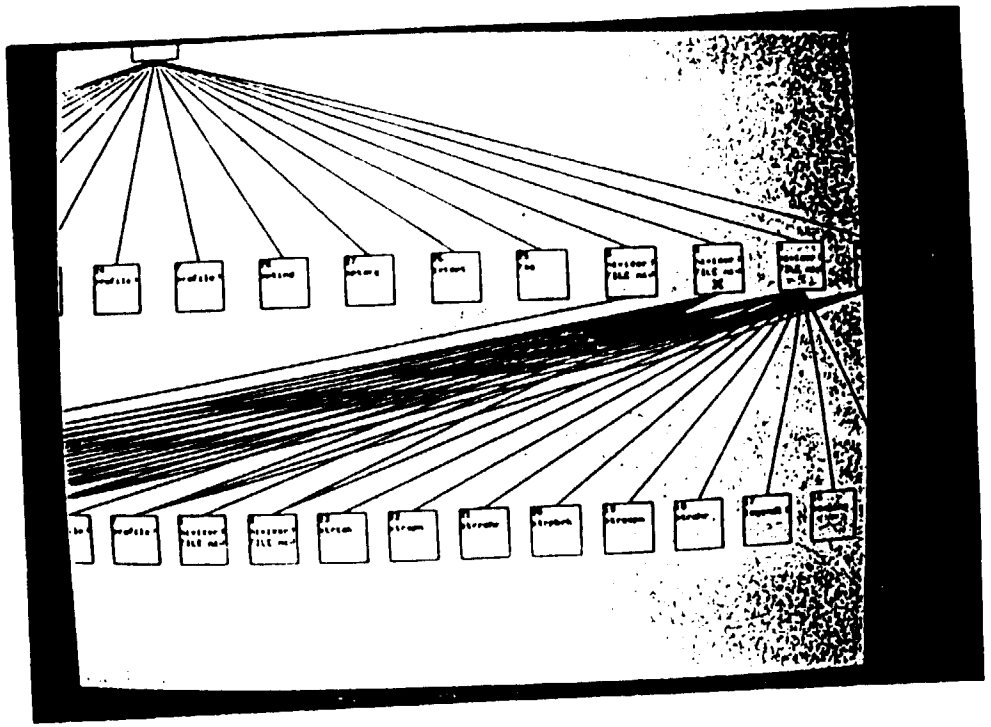
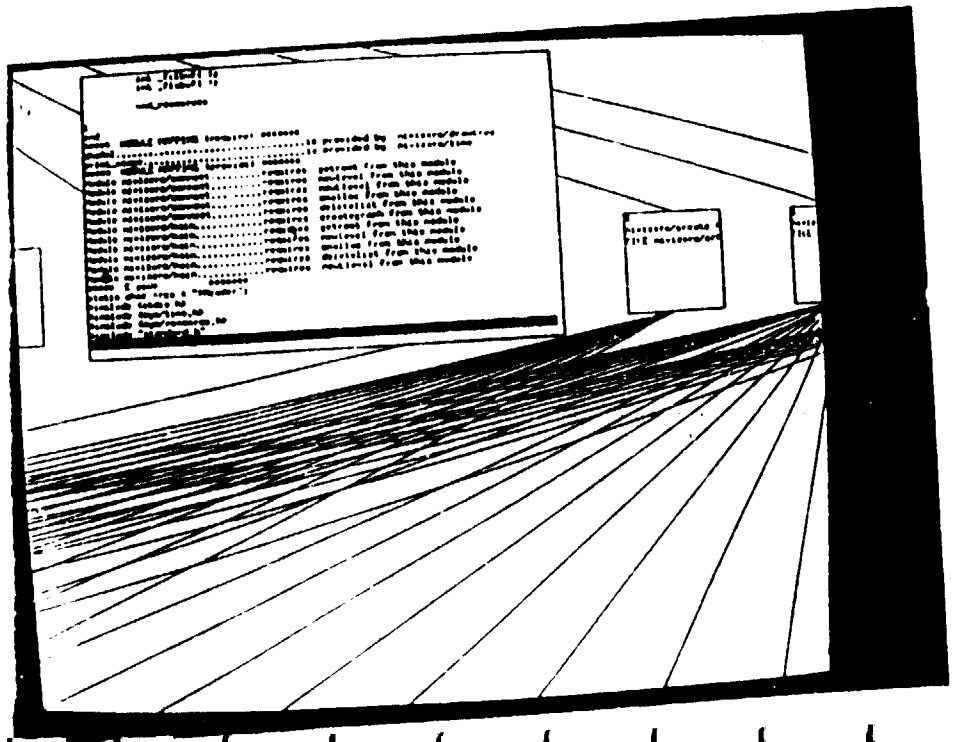
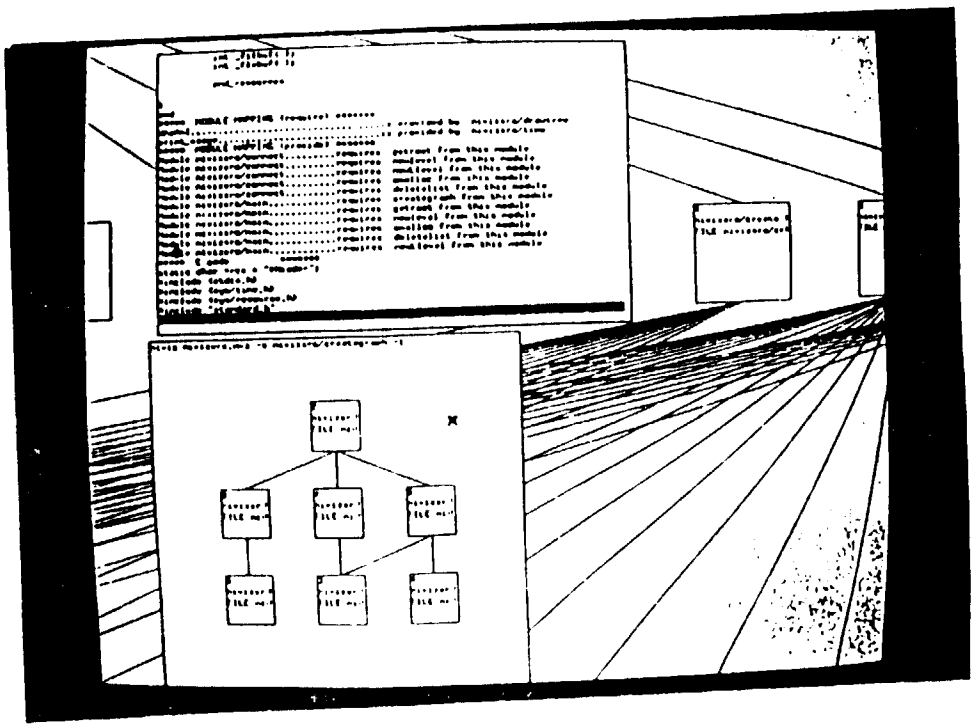
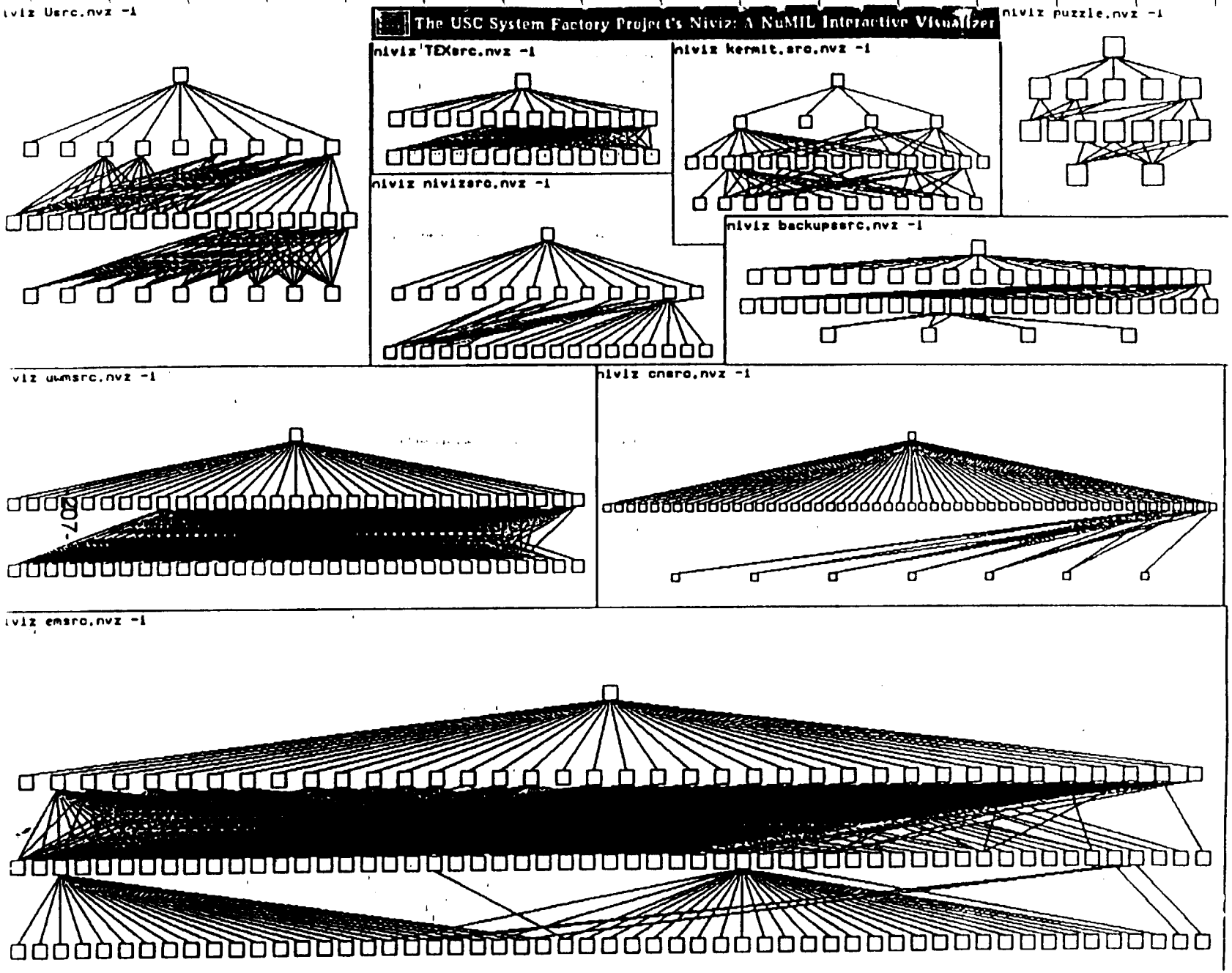
74










The USC System Factory Project's Nivis: A NuMIL Interactive Visualizer
niviz Usrc.nvz -i
niviz TEXsrc.nvz -i
niviz kermit.src.nvz -i
niviz puzzle.nvz -i
niviz nivisrc.nvz -i
niviz backupsrc.nvz -i
viz umsrc.nvz -i
niviz cnsrc.nvz -i
viz emsrc.nvz -i

Reverse Software Engineering

To take existing system source code then extract structural, behavioral, and – functional specifications (designs), or to restructure source, designs, or specifications.

Why?

- make old system compatible with new SE tools.
- Facilitate software maintenance.
- Facilitate intelligent software diagnosis, restructuring, recompilation, and retesting.
- Economic incentives.

Reverse Software Engineering (con't)

Structural extraction:

- Assumptions
- Translation scheme and directory analysis
- Include program extensions
- Construct resource flow graph
- Extract functional interconnections
- Extract functional interfaces
- Accomodate extraction anomalies
- Visualize, browse, or edit structural specifications
- Store or retrieve structural specifications in software hypertext nodes, or in NuMIL configuration management environment.

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Conclusions

- Demonstrated use of *software engineering hypertext environments*
- Demonstrated new technique for developing specifications of *multi-version software families*
- Demonstrated practical tools for *developing, managing, visualizing, and reverse engineering* configured software descriptions
- Demonstrated approach that scales up to manage *heterogeneous object descriptions* found in a *distributed, multi-location development project.*
- Some *open problems*
    - Better visualizations of software system and team configuration
    - Intermodular software resutrcturing
    - Extracting reusable components